THE OHIO JOURNAL OF SCIENCE

VOL. XLIV SEPTEMBER, 1944 No. 5

ANNUAL REPORT OF THE OHIO ACADEMY OF SCIENCE
1944

THE OHIO ACADEMY OF SCIENCE

Organized 1891 Incorporated 1892

Affiliated with the American Association for the Advancement of Science

OFFICERS AND COMMITTEES FOR 1944–1945

President

J. ERNEST CARMAN

Vice-Presidents

A. *Zoology:* MARION BOESEL
B. *Plant Science:* W. B. STEIDTMANN
C. *Geology:* GEORGE W. WHITE
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G. *Geography:* JAMES R. BECK
H. *Chemistry:* ROY G. BOSSERT
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J. *Junior Academy:* PHILIP DYE
K. *Anthropology:* RICHARD G. MORGAN

Secretary

A. W. LINDSEY

Treasurer

CLARENCE E. TAFT

Historian

WILLIAM H. ALEXANDER

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Elective: G. W. BLAYDES AND GEORGE W. WHITE

Trustees of the Research Fund

F. C. BLAKE, term expires.....1945
M. E. STICKNEY, term expires.....1946
HERBERT OSBORN, *Chairman*, term expires.....1947

Library Committee

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Librarian in charge of Academy Exchanges and Publications

WILLIAM LLOYD EVANS, term expires....1945
A. C. ANDERSON, term expires....1946

Committee on Conservation

E. LUCY BRAUN, term expires....1945
E. S. THOMAS, term expires....1945
WILBER STOUT, term expires....1945
ROSCOE E. FRANKS, term expires....1946
T. H. LANGLOIS, *Chairman*, term expires....1946
E. L. WICKLIFF, term expires....1946
G. W. CONREY, term expires....1947
L. C. DOW, term expires....1947
E. W. E. SCHEAR, term expires....1947

Committee on Nominations for 1944–1945

THE VICE-PRESIDENTS OF 1943–1944—E. W. E. SCHEAR, *Chairman*

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A. *Zoology:* WILLIAM C. BEAVER
B. *Plant Science:* C. J. WILLARD, *Chairman*
C. *Geology:* K. C. COTTINGHAM
D. *Medical Science:* NORMAND L. HOERR
E. *Psychology:* HERBERT A. TOOPS
F. *Physics and Astronomy:* J. L. GLATHART
G. *Geography:* F. J. WRIGHT
H. *Chemistry:* PAUL ROTHEMUND
I. *Mathematics:* *
J. *Junior Academy:* D. C. FAST
K. *Anthropology:* F. G. DETWEILER

Committee on Necrology

GEORGE D. HUBBARD, term expires....1945
F. H. KRECKER, *Chairman*, term expires....1946
CHARLES G. SHATZER, term expires....1947

Committee on Resolutions

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P. M. REA, term expires....1946
EUGENE VAN CLEEF, term expires....1947

Academy Representatives

1. On the Joint Administrative Board of the Ohio Journal of Science:
   WILLIAM LLOYD EVANS, term expires....1945
   A. C. ANDERSON, term expires....1946
2. On the Council of the A. A. A. S.: A. W. LINDSEY.
3. On the Save-Outdoor-Ohio Council: ROSCOE W. FRANKS.

The Council for 1944–1945

ANDERSON, A. C.
BEAVER, WILLIAM C.
BECK, JAMES R.
BILLS, ARTHUR G.
BLAYDES, GLENN W.
BOESEL, MARION
BOSSERT, ROY G.
CARMAN, J. ERNEST
COTTINGHAM, K. C.
DETWEILER, F. J.
DYE, PHILIP
EDWARDS, L. F.
EVANS, WILLIAM LLOYD
FAST, D. C.
GLATHART, JUSTIN L.
HOERR, NORMAND L.
JARVIS, C. W.
KRECKER, F. H.
LANGLOIS, T. H.
LINDSEY, A. W.
MILLER, MRS. ETHEL M.
MILLER, JOHN A.
MORGAN, RICHARD G.
OSBORN, HERBERT
ROTHEMUND, PAUL
SHETRONE, H. C.
STEIDTMANN, W. B.
TAFT, C. E.
TOOPS, HERBERT A.
WHITE, GEORGE W.
WILLARD, C. J.
WRIGHT, F. J.
YOWELL, E. I.

*The Mathematics Section has not elected a membership committeeman for the year.

REPORT OF THE FIFTY-FOURTH ANNUAL MEETING OF THE OHIO ACADEMY OF SCIENCE

The possibility of holding a meeting this year caused much discussion in the Executive Committee. Thanks to the willingness of members from the Ohio State University to assume responsibility for a second meeting in succession on their campus, plans were made for the usual gathering on May 4, 5 and 6, 1944.

The first meeting was that of the Executive Council at 8:00 P. M. on May 4, in the trustees' room of the Ohio State Museum. This meeting seemed unusually well attended and enthusiastic. No other evening programs had been planned.

Friday was devoted as usual to section programs. The sections on Physics and Astronomy and Mathematics joined forces, since other recent meetings in these fields had curtailed their programs. In spite of this abridgment a total of 94 papers appears in the annual program, in addition to a forum and some discussion periods. Since last year's program included 95 titles, we seem to have found our wartime level at this point. The program of the Junior Academy took place on Saturday, May 6.

The Ohio State Museum displayed an extremely interesting exhibit of enlargements from Dr. E. S. Thomas' nature photographs. For their technical excellence and artistic qualities as well as for their value in the field of nature study they were worthy of careful attention.

The annual banquet and business meeting were held again in the Faculty Club with Dr. L. H. Snyder as toastmaster. Following a greeting from President Howard L. Bevis of the Ohio State University and the response for the Academy by Dr. H. H. M. Bowman of Toledo University, President Shetrone read, as his retiring address, a paper on prehistoric irrigation in Arizona which introduced the group to an amazing chapter of human life in our continent with vivid suggestion of the fascination of archaeological research.

In the annual business meeting the report from the Council included the names of about fifty new members—a fine tribute to the work of section officers during the year—and the names of the following twenty-eight newly elected fellows:

Allison, Clyde C.
Bartley, Floyd
Beck, James R.
Cunningham, John F.
DeLor, Camille J.
Dickerman, E. Eugene
Doan, Kenneth H.
Edelmann, Abraham
Emo, Lorenzo
Glathart, Justin L.
Hollenbeck, Zeph J. R.
Humphrey, Sylvester S.
Miller, Mrs. Ethel M.
Myers, R. Maurice
Norris, Frederick H.
Pontius, Leslie L.
Popham, Richard A.
Puppel, Italo D.
Rabkin, Samuel
Reed, John F.
Rogick, Mary D.
Shanks, Royal E.
Stumm, Erwin C.
Sturgeon, Myron T.
Swanson, Carroll A.
Taylor, Mrs. Bayard
Tilford, Paul E.
Weishaupt, Clara G.

Dr. F. G. Detweiler read the report of the Resolutions Committee, expressing the Academy's appreciation to our hosts for again assuming the responsibility for a wartime meeting with such thoroughly gratifying results.

Respectfully submitted,

A. W. Lindsey, *Secretary.*

REPORT OF THE TREASURER

COLUMBUS, OHIO, May 4, 1944.

To the Ohio Academy of Science:

I submit herewith a financial statement of the condition of the Ohio Academy of Science as of December 31, 1943. The books have been audited and the opinion of the auditor is herewith attached.

Respectfully submitted,

CLARENCE E. TAFT, *Treasurer.*

OHIO ACADEMY OF SCIENCE BALANCE SHEET AS AT DECEMBER 31, 1943

ASSETS

CURRENT EXPENSE FUND:		
Cash on Hand		$ 15.00
Cash in Bank		518.13
Total Cash		$ 533.13
Interest Receivable		19.50
Bonds Owned:		
Federal Farm Loan 1945–55 (cost)	$1,300.00	
War Savings Bond Series F (cost)	111.00	
Total Bonds Owned		1,411.00
Total Assets—Current Expense Fund		$1,963.63
RESEARCH FUND:		
Cash in Bank	$ 234.78	
Banc-Ohio Securities Company Stock (cost)	437.50	
Bonds—Fort Hayes Hotel, Columbus, Ohio (cost)	1,300.00	
Total Assets—Research Fund		1,972.28
TOTAL ASSETS		$3,935.91

LIABILITIES AND NET WORTH

CURRENT EXPENSE FUND:		
Liabilities:		
Accounts Payable		$ 205.50
Deferred Credits:		
1944 Dues collected in 1943		35.00
Total Liabilities and Deferred Credits		$ 240.50
NET WORTH:		
Ohio Academy of Science:		
Current Expense Fund Surplus	$1,723.13	
Research Fund Surplus	1,972.28	
Total Net Worth		3,695.41
TOTAL LIABILITIES AND NET WORTH		$3,935.91

OHIO ACADEMY OF SCIENCE STATEMENT OF INCOME AND EXPENSE

For the Year Ended December 31, 1943

INCOME:		
Dues collected in 1943		$1,372.50
Grants for Research		172.00
Sale of Publications		10.66
Interest on Bonds		39.00
Total Income		$1,594.16
OPERATING EXPENSES:		
Subscriptions, Ohio Journal of Science	$858.75	
Printing:		
Proceedings Ohio Journal of Science	$103.68	
Other Printing	88.03	
Total Printing	191.71	
Research Grants	172.00	
Postage and Telegraph	35.32	
Office Supplies and Expense	28.58	
Expenses—Officers and Committees	25.88	
Secretary's Honorarium	100.00	
Auditing Expenses	15.00	
Bond of Treasurer	5.00	
Safety Deposit Box Rent	3.60	
Bank Charges	13.36	
Total Operating Expenses		1,449.20
EXCESS OF INCOME OVER EXPENSES		$ 144.96

AUDITOR'S CERTIFICATE

COLUMBUS, OHIO, July 1, 1944.

The Ohio Academy of Science,
Columbus, Ohio.

GENTLEMEN:

In accordance with your instructions, I have audited the accounts and records of the Treasurer of the Ohio Academy of Science for the year ended December 31, 1943.

I did not audit the Research Fund.

I hereby certify that in my opinion the books and records of the society are being kept in accordance with accepted accounting principles and the accompanying balance sheet of the Current Expense Fund as at December 31, 1943, and related statement of Income and Expense fairly present the financial condition of the Ohio Academy of Science (Current Expense Fund) and the results of operation for the year ended that date.

Respectfully yours,

DANIEL M. SHONTING,
Certified Public Accountant.

REPORT OF THE TRUSTEES OF THE RESEARCH FUND

The Research Fund of the Academy had a reported balance in the checking account on December 31, 1943, of $284.78. The additions credited during the year 1943 were $46.50 and a grant of $50.00 with service charges at bank of $1.14 gives a balance of $280.14 for December 31, 1943.

Summary of Receipts and Disbursements

Receipts

Balance in Bank as of December 31, 1942	$ 284.78
Receipts	46.50
Total	$ 331.28

Disbursements

By grant to Dr. Meyer	$50.00	
Service charges at Bank	1.14	
		51.14
Balance in checking account December 31, 1943		$ 280.14

Assets

Bonds (at cost)	$1,300.00
BancOhio stock (at cost)	437.50
Cash on deposit, Ohio National Bank	280.14
Total	$2,017.64

The allowance from the A. A. A. S. for 1944 is $165.00 and this has been granted, $100.00 to Dr. Meyer for continuation of a study of mineral nutrition of Russian dandelion, and $65.00 to Dr. Venard for further work on Ohio mosquito fauna.

While grants from our Research Fund must be of small amounts, they can give aid and encouragement to projects worthy of assistance and it is desired that they have as wide a distribution as possible for locality and field of investigation. They should not only give aid to worthy projects but stimulate research activity in many places and for many members of the Academy.

Respectfully submitted,

Herbert Osborn, *Chairman*,
Paul B. Sears,
F. C. Blake, *Trustees*.

REPORT OF THE EXECUTIVE COMMITTEE AND COUNCIL

The activities of our governing bodies were less extensive than usual, largely due to the serious illness of President Shetrone. The Executive Committee did little but plan for the annual meeting.

At the meeting of the Council February 12, on the campus of the Ohio State University, Dr. F. S. Howlett presided. The question of holding an annual meeting, reported favorably by the Executive Committee, resulted in unanimous approval of the meeting. The possible dates were subjected to a long discussion, due to the unusual conditions imposed on educational institutions by the war. It was finally agreed that the meeting should take place at the Ohio State University on May 4, 5 and 6, 1944. It was evident in the discussion that there is a division of opinion on the time for the annual banquet and business meeting and on the advantages of Saturday or preceding days for programs. Evidently a more general expression of opinion is to be desired on these points. Aside from acting on membership applications the Council considered no other business at this time.

The Annual Meeting of the Council took place in the Trustees Room of the Ohio State Museum at 8:00 P. M., May 4. The reports published herewith were presented at this meeting as required by the Constitution. They show that the affairs of the organization are in a prosperous state, only the circulation of publications apparently suffering rather seriously from the war.

At this meeting Dr. Glenn W. Blaydes of the Department of Botany and Dr. George W. White of the Department of Geology, Ohio State University, were elected to the Executive Committee for the coming year.

Steps were taken to assure the constitutional maintenance of the Committees on Necrology and Resolutions.

Nominations to fellowship resulted in the election of twenty-eight fellows, whose names are listed in the preceding report on the Annual Meeting.

The Council authorized the Treasurer to spend up to $25.00 per year for clerical assistance.

A motion was passed recommending that the Junior Academy consider association with the Science Clubs of America and report to the Council at its next meeting.

The meeting adjourned after a considerable period of semi-formal discussion of various aspects of the work of the Academy which demanded no specific action.

Respectfully submitted,

A. W. LINDSEY, *Secretary.*

REPORT OF THE JOINT ADMINISTRATIVE BOARD OF THE OHIO JOURNAL OF SCIENCE

COLUMBUS, OHIO, April 28, 1944.

To the Ohio Academy of Science:

The annual meeting of the Joint Administrative Board of the Ohio Journal of Science was held at the Ohio State University, April 28, 1944. The meeting was called to order by the Chairman, Dr. Snyder, at 11 A. M. Present were Drs. Snyder and White, representing the Ohio State University; Dr. Evans, representing the Academy, and Drs. Blaydes and Miller, representing the Journal, Dr. Spencer being unable to attend.

The minutes of the preceding meeting were read and approved. A motion presented by Dr. White and seconded by Dr. Evans that Drs. Blaydes and Miller be retained as Editor and Business Manager for the year 1944–45 approved.

The Business Manager's report was given by Dr. Miller. He called the attention of the board to the fact that the $251.02 surplus over 1942 should not be interpreted as indicating as accumulating asset. The cost of printing during the past year has increased by $234.66. It was possible to meet expenses during the past year due to the payment of $497.75 by the Academy for delinquent memberships. The Journal has effected to the limit economies through change in format, size of type, and reduction in number of pages. Further reductions are impractical and would effect no material savings.

The Business Manager wishes to place on record before the Academy the fact that with the increase in cost of production of the Journal additional problems in financing must be faced in the near future.

Drs. Snyder and White were appointed as auditors. A motion by Dr. Evans and seconded by Dr. White that the Business Manager's report be accepted. The motion was carried.

The financial statement follows:

THE OHIO JOURNAL OF SCIENCE—FISCAL YEAR 1943

RECEIPTS

Balance for 1942	$ 215.29
University allowance	750.00
Ohio Academy of Science—pro rata of dues	715.50
Ohio Academy of Science—Proceedings	103.68
Ohio Academy of Science—delinquent membership payment	143.25
Ohio Academy of Science—Balance from 1942	250.00
Subscriptions	111.00
Sale of back numbers	77.36
Author's payment for plates	43.46
Payments by authors and institutions of publication costs	148.75
	$2,558.29
Checks outstanding—O. S. U. Mailing Department	5.01
	$2,563.30

EXPENDITURES

Spahr and Glenn, Printing Vol. 43, and envelopes and stationery	$1,777.18
Bucher Engraving Company	261.50
Postmaster	30.00
O. S. U. Mailing Department	5.01
Bank charges	2.32
Student Auditing Fund	1.00
Clerical assistance	20.00
	$2,096.99
Balance on hand, February 14, 1944 (Huntington National Bank)	466.31
	$2,563.30

The Editor's report was given by Dr. Blaydes. The Editor reports that 44 papers, 28 book reviews and the Academy Proceedings were presented in 277 pages in Volume 43.

The problem of obtaining manuscripts under war conditions was discussed at some length. The Editor is continuing in his effort to obtain special invitation papers.

The Editor wishes to call attention to the board and through the board to the Academy the many difficulties which war conditions have precipitated. He asks that the Academy try to understand that delays in publication, reduced weight and quality of paper are but a few of the editor's war time problems. A motion by Dr. Evans and seconded by Dr. White that the Editor's report be accepted. The motion was carried.

A motion presented by Dr. White, seconded by Dr. Evans and passed by the board is as follows: The board desires to extend to the Editor and Business Manager of the Journal its sincere appreciation and approval in perpetuating a commendable publication under the most trying circumstances.

The meeting adjourned at 12:30.

JOHN A. MILLER,
Secretary of the Board.

REPORT OF THE LIBRARY COMMITTEE

COLUMBUS, OHIO, May 4, 1944.

To the Council of the Ohio Academy of Science:

The sales of publications plus sales tax amounted to $13.61. This sum, less 49 cents expended for fifty tax stamps, has been given to the Treasurer. Twenty-three items were sold in seventeen sales. Six were copies of Dr. W. G. Stover's Agaricaceae of Ohio and five of those were sold as a result of the favorable comments made about it by Mr. E. S. Thomas in a Sunday issue of the *Columbus Dispatch* last August.

This is the fourth year that the Ohio Journal of Science has not been sent to foreign countries in the eastern hemisphere and the third year that it has not been mailed to the other Americas. The stock became too large for the storage facilities of the mailing room and as the main building of the Ohio State University library had no place for it, it was all brought over to the Botany and Zoology library where it was assembled into volumes, wrapped, marked, and stored on top of the book stacks. The surplus for each issue is brought and put away in the same manner. The volumes will be posted at the end of the war to the exchanges whose libraries are still in existence.

Two years ago the members of the library committee considered ways to circulate more of the stock of the Annual Reports and special papers of the Academy. Two plans were proposed and the results were to be reported the following year. One plan was to send the price list again to book dealers. This was done and the report was made last year that it has produced no results. The other plan was to make use of the forthcoming new edition of the Union List of Serials in order to ascertain the various numbers of the Proceedings which were lacking in the libraries listed in it and offer to supply them on a sale or an exchange basis as the case might be. As the publication of the Union List was postponed for a year, the report on this plan had to be held over until this year.

Ninety-five libraries in this country and Canada reported their holdings of the Ohio Academy of Science Proceedings in this new edition. Of this number, twenty-five libraries in the United States and two in Canada reported complete sets. Notices were sent to twenty libraries which had more than just a few stray numbers, offering to supply what they lacked if the numbers were still available. So far replies have been received from twelve, with the result that five of them had complete sets without realizing it. This was due to the fact that the name "Proceedings" and the volume numbering did not begin until the twelfth report which Professor J. H. Schaffner marked as volume four, part 1. He assembled the first eleven reports and the first seven special papers into three volumes, and although he was very careful to give a full explanation in the twelfth report, yet quite a number of libraries assume that they lack the first three volumes of the Proceedings. Two libraries reported having complete sets except for one paper, the unavailable Trees of Ohio, by Professor Schaffner. Their sets were completed for three libraries, and for another except for this one paper, so that now the record is that thirty-five libraries in this country and Canada have complete sets and five more lack only the one paper. But not much stock was used as filling in the sets in the four libraries required only ten special papers and forty-three annual reports. Correspondence will be maintained with more of the libraries that are cited in the Union List of Serials.

As a result of the notice published in the November issue of the Ohio Journal of Science that a copy of Professor E. L. Moseley's book on Milk Sickness caused by White Snakeroot would be sent without cost, twelve copies were posted to members of the Academy living in various parts of Ohio and in two other states. Three more members will be supplied later with copies.

One new exchange was secured, another was resumed as publication was begun after a lapse of thirty years, and one of long standing was transferred from the exchange list of the Academy to the subscription list of the Ohio State University library as the organization had found it necessary to curtail the number of its exchanges.

Respectfully submitted,

Warren P. Spencer,
William Lloyd Evans,
Ethel Melsheimer Miller, *Chairman.*

REPORT OF THE COMMITTEE ON NECROLOGY

To the Ohio Academy of Science:

Your Committee deeply regrets to report the death of four members of the Academy which have been brought to its attention. The names are those of Dr. Arthur T. Evans, Prof. Ralph A. Schaller, Dr. Adam P. Seyfried, and Dean Alfred Vivian.

Arthur T. Evans—The death of Dr. Arthur T. Evans, Head of the Department of Botany at Miami University, occurred on October 5, 1943, in Oxford, Ohio, after an illness of several months. He was born in Wellington, Illinois, in 1888. He came to Miami University in 1928 from South Dakota State College, where he had been head of the Department of Botany and Plant Pathology since 1920. During the year 1918–1919 he conducted investigations on cereal crop diseases in the Great Plains area for the United States Department of Agriculture. His academic training was received at the universities of Illinois, Colorado, and Chicago. Early experience as a teacher was gained in the Wakefield, Michigan, Township High School, of which he was principal. With the coming of World War II he became actively interested in promoting the development of Victory gardens in the region about Oxford.

The scientific organizations of which Dr. Evans was a member were the American Botanical Society, American Association for the Advancement of Science, Sigma Xi, and Phi Sigma. He joined the Ohio Academy shortly after coming to Miami University and was made a Fellow in 1931

RALPH A. SCHALLER—An active and useful life came to an all too early close in the death of Professor Ralph A. Schaller, of Bowling Green State University, at Bowling Green, Ohio, on February 3, 1944, a few weeks short of his forty-third birthday. In 1940 he had become instructor in biology at Bowling Green and in 1943 he was advanced to the rank of Assistant Professor. His scientific interests were primarily in the field of botany. His early professional life had been largely devoted to high school instruction. In 1931 he received the degree of Master of Arts from the Ohio State University and subsequently continued work toward the doctorate. His high school experience quite naturally developed an interest on his part in the junior division of the Ohio Academy of Science and for a time he was vice-president of the Junior Academy. An active interest in the problems of conservation led to his election to the presidency of the Wood County Natural Resources Council. In addition to being a member of the Academy he belonged to the American Association for the Advancement of Science.

The wide range of Professor Schaller's interests is shown by the fact that he had served two terms on the Bowling Green city council, was leader in his church and had been twice president of the Bowling Green State University Alumni Association.

ADAM P. SEYFRIED—Dr. Adam P. Seyfried was Associate Professor of Biology at the University of Dayton. His sudden death in Dayton after a brief illness on August 29, 1941, at the age of 44, brought to an untimely end a career as teacher in the educational institutions of the Society of Mary which had been most successful and gave full promise of even greater usefulness. He was beloved by all who knew him, colleagues, students, and friends alike, for his geniality, kindness and sincerity of character. After graduation from the University of Dayton he taught in California and in Detroit. He then did graduate work at the University of Fribourg, Switzerland, from 1924 to 1928, from which institution he received the degrees of Master of Arts and Doctor of Philosophy. His research was on the anatomy and histology of the myrmicophilous histerid *Chrysetaerius iheringi*. Following a six-year term as pricinpal of St. James High School in California he joined the faculty of the University of Dayton in 1925.

Besides membership in the Ohio Academy of Science he held membership in the National Association of Biology Teachers and in the American Association for the Advancement of Science.

ALFRED VIVIAN—In the death of Dean Alfred Vivian, the distinguished Dean Emeritus of the College of Agriculture of the Ohio State University, the University, the Ohio Academy of Science, the state and the nation have lost an outstanding leader in the development of scientific agriculture. He died in Columbus, Ohio, at the age of 76 on October 23, 1943, from a heart ailment after a three-day illness. Those who knew him ever remember his genial nature, those who worked with him will miss his kindly and sound counsel, and those who enjoyed his intimate acquaintance will cherish memories of warm and loyal friendship. Dean Vivian's early scientific interest was in agricultural chemistry in which field he obtained his doctorate at the University of Wisconsin and in which he began his career at the Ohio State University in 1902 as an Assistant Professor. His subsequent work in this phase of chemistry was outstanding and his development of the Department noteworthy. His broad interest in agriculture, his grasp of rural problems, and his keen and enthusiastic appreciation of the possibilities in scientifically conducted agriculture led to his selection as Dean of the College of Agriculture in 1915. Under his direction this division of the University reached a position of leadership in the agricultural world. He was a member of numerous scientific organizations and was elected Fellow of the Academy in 1920.

When he gave up his active professional life, Dean Vivian continued his interest in the life of the rural dweller, and of the city dweller as well, by sharing with others his unusually large collection of musical records through the medium of broadcasting station WOSU. Up to the time of his death he planned, supervised, and frequently announced a daily program entitled "World Famous Music," made up of records taken from his library.

Respectfully submitted,

FREDERICK H. KRECKER.

A UNIQUE PREHISTORIC IRRIGATION PROJECT[1]

HENRY C. SHETRONE
Ohio State Archaeological and Historical Society
Columbus, Ohio

Intentional diversion of water from its natural channels, for the purpose of irrigating regions of inadequate rainfall, is widespread in time and space. Usually, however, it is thought of as something of an innovation and as of more or less local significance.

Inhabitants of humid areas are likely to under-estimate the very considerable portion of the earth's surface where the natural supply of moisture is insufficient to meet the needs of agriculture and other human economic requirements. In the United States alone virtually one-half the land area, westward from its longitudinal center, is arid or semi-arid, as are vast areas in Mexico and South America.

Much of the Old World, particularly those countries adjacent to the Mediterranean and in the Near East, where ancient civilizations originated and flourished, are arid and desert-like. The valleys of the Tigris, the Euphrates and the Nile are classical examples of the dependence of life on the natural or induced overflow of these great river systems.

The importance of water—and the tragedy of too much or too little—are reflected in the early literature, both sacred and profane, from the time of the Babylonian poet-philosophers downward through the centuries. An outstanding record of excessive rainfall is that of the Noachian flood; a minor example may be found today in the rain belt where someone, perhaps with a picnic in prospect, hopes that tomorrow may be fair! In between, the annals of virtually every people contain legends of floods and consequent devastation. Because of insufficient rainfall Moses, leading the Children of Israel back to the homeland, smites the rock, that they may drink; and the Arab sheik bespeaks the compassion of Allah in the matter of the failing desert spring.

The crude methods of conserving water for domestic and agricultural use employed by present-day Pueblo Indians of the arid Southwestern United States are a matter of common knowledge. Natural springs and water holes are seasonal sources; rivers which carry water through the year serve those living adjacent thereto; but by far the greater number of inhabitants must conserve rainfall and storm water from the mountains and the high mesas in natural depressions, converted into reservoirs by means of dams and other artificial modifications. While in some instances ditches lead from these to nearby fields and gardens, the Indian women usually must carry water in jars for hand-irrigation of their meager crops. Archaeological investigation has shown that, with few exceptions, surprisingly similar methods were employed in prehistoric times in the same general area.

This paper, however, is concerned with the historic aspects of irrigation only as a frame or background for an even more romantic phenomenon—prehistoric irrigation in the New World!

Although a matter of record, it is not generally known that in South-central Arizona, long before the discovery of America, the native aborigines had perfected an impressive system of irrigation, which made possible the successful practice of agriculture over a period of several centuries. This system has been referred to as a "million-dollar project, constructed with nothing more than rude stone hoes and wooden digging sticks."

[1]Address of the retiring President of the Ohio Academy of Science, delivered at the annual meeting of the Academy held in Columbus, Ohio, May 5, 1944.

Residents of Ohio and adjacent parts of the Middle West, where the civilization of the so-called Mound Builders has been made known through exploration of their ancient tumuli, may not find this so incredible; but to many persons, accustomed to think of all prehistoric peoples as mere savages, the phenomenon is certain to be something of a surprise.

A glance at the map of the southwestern United States will serve to set the stage for the human drama which now unfolds itself. It will be noted that the state of Arizona, youngest of the American commonwealths, is bounded on the north by Utah and Colorado; to the east is New Mexico, and to the south is old Mexico. The great Colorado river, beyond which is California, forms Arizona's western boundary.

Traversing the state from northwest to southeast are southern extensions of the Rockies, and the high plateau, where today live the Pueblo Indians and where in ancient times lived their predecessors, the prehistoric Pueblos and the so-called Basket Makers. To the west and south of the mountains is the Arizona desert region of scant rainfall, where, because of its much lower altitude, relatively high temperatures prevail.

In south central Arizona is the city of Phoenix, capital and metropolis of the state. From the mountains and high plateau toward the east come two rivers—the Salt from the northeast and the Gila from the southeast. They converge just west of Phoenix and find their way, as the Gila river, to the Colorado and the Gulf of California.

The State of Ohio sometimes is referred to as the land of the Mound Builders; the valleys of the Salt and the Gila, particularly the region of which Phoenix is the hub, may with equal justification, be referred to as the land of the Canal Builders! Here we have the double phenomenon of an area of considerable extent, by nature arid and uninviting which, for several centuries in prehistoric times, was made to "blossom as the rose"; which then reverted to its natural aridity; and now, once again, has become one of the more fertile and productive regions of the continent!

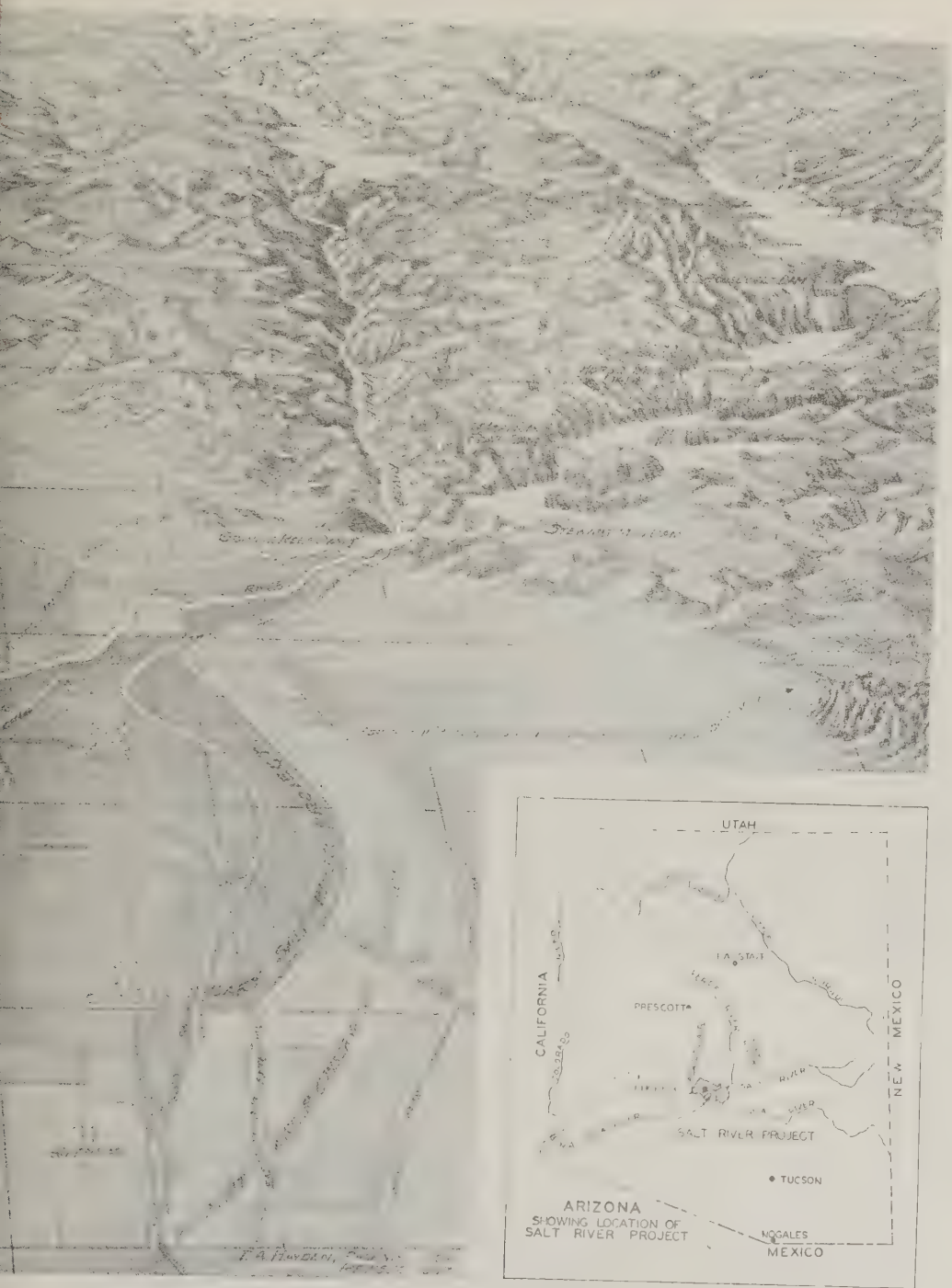
The visitor to Phoenix need walk but a short distance outside the city limits to come upon one or more ancient irrigation canals. Accompanied by a guide familiar with the terrain, he will be able to trace a number of others, and will learn that prior to their partial obliteration by present-day agriculture, some 125 miles of main irrigation canals were existent in the Salt river valley and perhaps half that mileage in the valley of the Gila. Many of these measure as much as 30 feet between their crowns and reach depths of ten feet or more. Even at this late date some of these may be traced for as far as ten miles.

The canal system in the Salt river valley consisted of several independent units, or main canals, each with many branch canals and ditches. Intakes of the main canals were far enough up-stream to provide sufficient "fall" for successfully irrigating their respective areas. The lateral branches, most of which long ago were obliterated through erosion and silting, must have aggregated hundreds of miles.

An aerial survey of the valleys of the Salt and the Gila was effected in 1930 through the cooperation of the Smithsonian Institution, the United States Army, and certain authorities in Arizona. This aerial reconnaisance, during which the region was accurately photographed and mapped, was followed by a ground survey under the direction of Phoenix city archaeologist, O. S. Halseth. As a result of this dual survey, what admittedly is the only true irrigation culture in prehistoric America has become a matter of record.

This brief outline of prehistoric irrigation and agriculture in Arizona should elicit a desire on the part of the listener to learn something of the people responsible for their development. Who were the ancient Canal Builders? Spanish paesdr and adventurers from old Mexico, who came into the region toward the close of

Fig. 1. Present-day irrigation in the Salt River valley, south-central Arizona. The prehistoric irrigation project covered the central portions of the same area.



ARIZONA
SHOWING LOCATION OF
SALT RIVER PROJECT

the Seventeenth Century, perhaps were the first white men to ask this question. Naturally, they sought the answer from the native Indians, the Pimas, resident in the district, and received the reply, "Ho-ho-kam!" meaning nothing more nor less than "those who have vanished." The canals and the adjacent ruins already were abandoned and ancient as far back as Pima tradition carried.

Thanks to archaeological researches sponsored by the University of Arizona; the City of Phoenix; Gila Pueblo of Globe, Arizona; the Bureau of American Ethnology and other agencies, the erstwhile forgotten annals of the Canal Builders in great part have been recovered and recorded. This is particularly true of the material aspects of their culture.

As indicated by their numerous irrigation canals, the Hohokam peoples were agriculturists. In and adjacent to the Salt river valley there are the ruins of some

2. Typical landscape of unirrigated section of Salt River Valley.

20 ancient farming communities, each with its central communal adobe structure, with perhaps half that number in the valley of the Gila. The most impressive of these ruins in the Gila drainage is the noted Casa Grande, now preserved as a national monument.

Outstanding in the Salt river valley is Pueblo Grande, a part of the park system of the city of Phoenix, located just east of the city limits. Here the enterprising capital city of Arizona has erected an Anthropological Laboratory in which is housed a museum of the Hohokam culture, workrooms and laboratories, accommodations for visiting anthropologists and students, and living quarters for the Director of the Laboratory, who also has the title of City Archaeologist. During the months of February and March, 1944, your speaker had the pleasure of being a guest at the Laboratory, with unusual opportunity for studying the Hohokam culture at first hand.

A brief description of Pueblo Grande ruin and its adjacent farming community

will serve as an index to the culture as a whole, which is quite homogeneous throughout the area of its occurrence.

The ruin of the Pueblo Grande community structure, adjacent to the Laboratory, is a more or less rectangular truncated mound of earth and stone, some 150 feet in width and 300 feet in length with an approximate height of 30 feet. It has been partially excavated by Director Halseth and his associates and students, and proved to consist of a large number of rooms or compartments of varying sizes. The walls and partitions are constructed of flat stones and boulders imbedded in adobe clay, with roofs of logs, poles, brush and adobe. Enclosing the structure, and built from similar materials, was a high wall. Entrance to the resulting compound presumably was by means of ladders. The structure and its compound served the community as a granary and storehouse for their corn, beans, squash and other products and possessions, and as a safe retreat from marauding tribesmen from outside their borders. The great size of the structure and its many rooms are accounted for by the fact that adobe construction was at best only temporary or semi-permanent, and required frequent repairs, abandonment of certain parts, and the building of new units.

Outside the compound and adjacent thereto were the cultivated fields, comprising many acres. Here too the people lived, their domiciles being merely crude shelters of poles and brush, their floors somewhat below the surface of the ground—a type of domicile known to archaeologists as "pit houses."

It would be unfair to judge the culture of the Hohokam peoples solely by their unassuming dwellings, for it should be remembered that in the mild climate of their country they could be, and were, people of the great outdoors. Their amazing system of irrigation canals and the resulting agricultural development, together with their pretentious communal centers and their ceremonial ball courts, are sufficient to place them on an advanced plane of culture; nor should one overlook their admirable development of the minor domestic arts. While little of a perishable nature has survived the destruction wrought by time and the elements, their utilization of clay, stone, shell and other time-resisting materials, is in keeping with their major accomplishments. The potteryware of the Hohokam, particularly, is exceptional and many fine examples of pots, jars, vases and bowls, of pleasing form and decoration, have been recovered. Equally impressive, if not as artistic, are the numerous metates and manos, for grinding corn and other grains and seeds, while their stone axes are among the finest known. Beads, pendants, bracelets and necklaces of shell and other materials are much in evidence, and turquoise occurs sparingly. Chipped flint projectile points and knives, while often of good workmanship, are much less abundant than in the Middle West, obviously for the reason that the Hohokam were mainly agricultural and only moderately dependent on wild game for food. Tobacco pipes are of very infrequent occurrence, as contrasted with Ohio, where large numbers are found in the ancient mounds and burial sites. Tobacco doubtless was ordinarily smoked as cigarettes.

While archaeologists specializing in the culture are virtually agreed that the Hohokam came into the Salt and Gila valleys at or slightly before the beginning of the Christian era, there is no definite evidence as to their origin. There *is* some evidence of affinity with the lesser-known Mogollon and Coshise cultures to the south, and of contact with the Pueblo peoples to the north, but the full significance of these remains undetermined.

Fortunately, however, the approximate period of their occupancy and the probable time and cause of their disappearance from their homeland in Arizona now are known. The techniques employed in discovering and recording a major part of the story of the Hohokam peoples, after the lapse of centuries, not only is a romance in itself, but is an example of the efficiency of the methods of archaeology as well. Here, briefly, is the story.

Earlier in this paper it was stated that the Hohokam are believed to have come into south central Arizona around the beginning of the Christian era. At this point it may be stated that they disappeared from the region around 1400 A. D., some three centuries prior to the arrival upon the scene of Spanish explorers and adventurers from old Mexico. For the evidence on which this chronology is

3. View of mountains from Apache Trail, east of Phoenix. Upper course of Salt River, source of irrigation water, seen through the gap.

based, we must turn momentarily to another region and another people—the Pueblo nations of the high plateau and canyons.

Here in a region of evergreen forests, the ancient ruins of the Pueblo peoples actually have been "dated" by means of tree ring counts, a technique developed by Dr. A. E. Douglass of the University of Arizona. Details of this immeasurably important development cannot be given in the limited space of this paper. It is one of the romances of American science. (See bibliography.) Suffice it to say that most of the major ruins and scores of minor ones in the Southwest now have been dated by this method, and that the chronology of the region has been carried back to the First Century A. D.

4. Section of a prehistoric irrigation canal, just east of Phoenix.

As a result of the tree ring method of dating, those ruins in forested areas adjacent to the Hohokam country show significant changes through the centuries in types and decorations of pottery-ware and in virtually every aspect of their material culture; and since there was more or less of trade and barter as between the two areas, the finding in a Hohokam site of a Pueblo pottery vessel of, let us say, the period of 1000 A. D., is suggestive to say the least. Multiply such individual instances by any reasonable number, and at least a near-contemporaneity is the result. Although the Hohokam country is virtually lacking in large trees, through such analogy and comparison its ruins are dated.

Finally, when all evidence of Hohokam activity ceases, and no further objects known to pertain to other cultures appear in their ruins, it is logical to assume that their career as a people was ended. Such conditions are found to obtain not much later than 1400 A. D.

The disappearance of so advanced a people from a region which they had converted into an admirable place of residence was due to two major causes. One of these is disclosed in a brief consideration of the present-day situation.

In the 1870's Mormon settlers appeared in the Salt river valley and began clearing out ancient irrigation canals and constructing others. In the ensuing years this initial enterprise has grown by leaps and bounds, with some 400 square miles of terrain, requiring annually 1,000,000 acre-feet of irrigation water, now under cultivation. Thus the land of the ancient Canal Builders once more has come into its own, and the Salt river valley—the Valley of the Sun—with its great citrus groves, date orchards, farms which produce as many as three crops annually, and sub-tropical plants and flowers growing in great profusion, is indeed an oasis in the desert.

In view of the fact that this transformation is due entirely to irrigation, it may appear contradictory to suggest that irrigation was the principal cause of the

5. Small section of Casa Grande ruins, partly explored.

downfall of the Hohokam peoples. The Salt river valley is underlaid with a "volcanic pocket" of clay or marl which is virtually impervious to water. According to estimates of the Salt River Waters Users Association, one-fifth of the total irrigation water enters the ground as seepage, and builds up the water table at the rate of from three to five inches each year. During the period from 1870 to 1920, when irrigation was much less intensive, one-third of the area under irrigation was rendered unfit for cultivation as a result of accumulated seepage and attendant alkalinity. Under present-day intensive irrigation, the entire area, within a comparatively short time, would be little short of an alkaline bog. This threat now is averted by periodic flooding to eliminate alkali and by using a battery of electric pumps for the purpose of removing surplus water—some 300,000 acre feet annually.

The ancients had no drainage facilities, pumps or otherwise. The result was

inevitable; surplus water and alkalinity, water-logged soil, and dwindling productivity. This is evidenced by the fact that exploration of the Pueblo Grande ruin demonstrated that the floors of granaries and store-rooms had repeatedly been elevated in an effort to keep them above the water-logged surface of the ground.

An additional situation, which may have been the *coup de grace* of Hohokam survival, was the constant threat from marauding nomadic tribesmen from the plateau areas. It is known that from early historic times the agricultural peoples of the valleys were frequently raided by the Navajo, the Apache and other predators who made bold to reap where they had not sown, and there can be but little doubt that the peaceful Hohokam peoples, throughout their sojourn in their chosen country, were forced to contend with similar hostile incursions. Faced by such handicap, and seeing their once fertile acres gradually transformed into water-logged and alkaline wastes, it was inevitable that their numbers must decline to the point where a few hungry stragglers either found refuge with other tribes or passed entirely from the picture.

Today there remain only the old canals and the ruins of once impressive communal structures—mute evidences of a people who had carried the human experiment, through trial and error, to a level which must command the admiration of all discerning men; a people who, but for a natural calamity with which they could note cope, and because of the rapacity of unscrupulous and hostile neighbors, might have borne the torch of civilization to undreamed-of heights The construction of a million dollar irrigation system, representing a high degree of engineering skill, attests to their energy, strength, courage and initiative.

Our culture of today is complex, while theirs was simple; but who would venture to say that ours is "higher" or better? We, as were they, are still beset with the threat of natural calamity, and by "man's inhumanity to man." The first of these is nothing as compared to the latter, which now has precipitated all mankind into a holocaust such as the world never has known, the aftermath of which conceivably might be more disastrous than the titanic struggle itself.

The only criterion which justifies an assumption that one culture is higher or better than another, is proof that it provides a larger measure of cooperation, usefulness, spirituality, morality—and human happiness!

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THE RESEARCH FUND OF THE OHIO ACADEMY OF SCIENCE

HERBERT OSBORN
The Ohio State University
Columbus, Ohio

The special research fund of the Academy was inaugurated by an initial donation from Mr. Emerson McMillin at the Academy meeting of 1898 and his contributions were continued until his death in 1922, at which time there had been accumulated under the careful management of Dr. Mendenhall a balance of over $1,300.00 which was invested and the income from which has in part been used in grants during the later years.

A record of the grants made during the passing years, now nearly a half century, would seem to be a worth-while effort and since the writer has had some connection with the use of the fund during many of these years, it seems appropriate to undertake the task, especially as it was his privilege to collect some data in this connection at the time of the celebration of the half century of Academy history.

That a small grant such as was possible with the initial $250.00 can be made to secure large results is, I think, demonstrated by the record and it may be said that these grants have had the effect of not only furnishing the needed assistance in the provisions for travel expenses or the apparatus for various investigations, but have been a very effective stimulus toward the undertaking of research problems which might otherwise have been neglected. Certainly in many cases the grants have been the means of providing opportunity to teachers or students who could afford the time but lacked certain facilities to pursue investigations for which they were well qualified but lacked the means to finance them from their individual resources. That the fund has had the effect of encouraging research work on the part of some who would not have been attracted to it is, I think, also evident.

In this summary review of the projects assisted by the fund it may be of interest to note that the very first grant, which was to Prof. W. G. Tight, of Denison University; J. A. Bownocker, of Ohio State University, and Dr. J. H. Todd, of Wooster, was for a distinctly Ohio problem, the Preglacial Drainage of Ohio, and quite naturally the great majority of the projects assisted have been of a state character relating largely to the geology and biology, utilizing local talent for the study of local problems which often have world-wide significance.

For the Fifty Year Celebration the writer brought together a preliminary list of the grants, the persons receiving them and subjects of the investigations which were submitted to the committee on history, but naturally with the large amount of material accumulated for that event there could be little place for this record and no extended publication of the data has been given aside from the list of "Grants from the Research Fund," appearing in an article by historian W. H. Alexander, *Ohio Journal of Science*, Vol. 41, p. 304. That list is lacking in some details and might be misunderstood since grants listed as allotted were in some cases not used and in others the project delayed and the actual payment made in a subsequent year. Also no record is made of the subjects of the various projects which might be of interest to those who care to look into the distribution of the fund. The amounts noted in that list give substantially the distributions made from the McMillin donations and need not be repeated. They amounted to over $6,000.00 in all and may be treated separately from the grants allotted by the A. A. A. S. in recent years and considered in a separate paragraph. Also as noted in a quotation from the by-laws, certain items such as life membership, donations

and sale of publications are to be placed in the research fund and income only used for grants in aid of research. (See paragraphs from by-laws below.) See also Report of Trustees, April 30, 1932, in Proc. Ohio Acad. Sci., *Ohio J. Sci.*, 32: 280–1. A. A. A. S., 1930

The first Board, 1898, consisted of F. M. Webster, W. R. Lazenby, E. L. Moseley, *vide*, p. 13, 7th Annual Report.

Grants as made by years were as follows:

1899. The first grants made from this fund in 1899 went to W. G. Tight, Preglacial Drainage of Muskingum Valley; J. A. Bownocker, Preglacial Drainage of Miami Valley; J. H. Todd, Preglacial Drainage in Wayne County; R. C. Osburn, Fishes of Northern and Southern Ohio, with later allotment for printing the Preglacial papers.

1900. To Gerard Fowke, Preglacial Drainage, Cincinnati; R. C. Osburn, for continuance of Fishes of Ohio; T. A. Bonser, Flora of Big Spring Prairie; Prof. J. S. Hine, Insects of Certain Parts of Ohio.

1902. J. S. Hine, Tabanidae of Ohio, two grants, published in Special Papers No. 5. Lynds Jones, "Birds of Ohio," two grants, published as Special Paper No. 6. F. L. Landacre was given two grants for studies on Protozoa, later published as Special Paper No. 13. Max Morse, grant for study of Batrachians and Reptiles of Ohio, and expense of publication, Special Paper No. 9. J. H. Schaffner, Ecological Study of Brush Lake, Special Paper No. 10.

1903. T. A. Bonser, Flora of Big Spring Prairie, published as Special Paper No. 7, "Ecological Study of Big Spring Prairie."

1904. F. L. Landacre, Studies on Protozoa, two grants. Max Morse, Reptiles of Ohio, Special Paper No. 9. J. G. Sanders, Coccidae of Ohio, published as Special Paper No. 8. Several small grants for Ecological Study of Brush Lake by J. H. Schaffner.

1905. R. F. Griggs, "Willows of Ohio, Special Papers No. 11. Herbert Osborn, two grants for "Study of Insects of Ohio," published in articles appearing in 8th Annual Report, *Ohio Naturalist* and Bulletins of Ohio Biological Survey.

1906. W. B. Herms, Relations of Insects to Organic Debris on Lake Beaches. J. E. Hyde, Upper Waverly Formation in Central Ohio. F. Carney, Local Glacial Geology Near Granville. Chas. Brookover, Fiber Tracts and Neurones of *Amia calva*. Victor Sterki, Land and Fresh Water Mollusca, Special Paper No. 12.

1907. W. C. Morse, for "Studies on Maxville Limestone," published as Special Paper No. 17, Fauna of the Maxville Limestone.

1908. A. Dachnowski, Peat Bogs in Ohio. H. S. Hammond, Mosses and Liverworts in Ohio. S. Morgulis, "Regeneration in Plants." L. B. Walton, "Naididae of Ohio." Freda M. Bachman, Special Papers No. 14, "Discomycetes in the Vicinity of Oxford," "published by the McMillin Fund." G. E. Goghill, "Breeding Opossum in Pens under Controls to Secure Embryos," published in *Ohio Journal of Science*, Vol. 39, pp. 239–249.

1909. J. H. Schaffner, "Trees of Ohio and Surrounding Territory," published as Special Papers No. 15. Walton, "Fresh Water Oligochaetes of Ohio," and Freda Detmers, "On the Genus Carex." A. Dachnowski, "Peat Bogs of Ohio." G. E. Coghill, "Opossum," and R. J. Sim, "Nesting of Birds in Northeastern Ohio."

1910. J. H. Schaffner, "Pteridophytes of Ohio," for publication, Special Papers No. 16.

1911. W. C. Morse, "Fauna of Maxville Limestone," Special Paper No. 17. W. M. Barrows; A. Dachnowski, "Peat Bogs of Ohio," published in Bulletin 16, Ohio Geological Survey as "Peat Deposits of Ohio," also in *Bot. Gazette*.

1912. W. G. Stover, "The Agaricaceae of Ohio," Special Paper No. 18. "Ecological Study of Buckeye Lake," by Freda Detmers, Special Papers No. 19. L. B. Walton, "Fresh Water Oligochaetes." J. S. Hine, "Mammals." A. Dachnowski, "Peat Bogs of Ohio" (see above). W. J. Kostir, "Orthoptera of Ohio."

1915. R. F. Griggs, Plant Ecology in Ohio. L. B. Walton, Fresh Water Organisms. W. H. Bucher, Related Localities of Wavy Sedimentary Strata. J. S. Hine, Collecting Insects in Northeastern Ohio. S. R. Williams, Richmond Deposit in Butler County.

1916. Williams and Shideler, "Richmond Division of Ordovician." L. S. Hopkins; B. W. Wells, Zoocecidia on *Celtis occidentalis*. F. L. Landacre, for set of eggs of Marine lamprey *Petromyzon* to study origin of cerebral ganglion.

1917. Forrest B. H. Brown, Determining main forest types in Ohio. S. R. Williams, Geology in Southwestern Ohio. W. M. Barrows, Effect of radium on germ plasm.

1918. G. D. Hubbard, Geography of Columbus region. E. L. Rice, Chondrocranium of Eumeces. L. B. Walton, aquatic organisms. E. N. Transeau; H. W. Lutz, "Root Rots of Apples."

1919. J. S. Hine, Ohio Mammals; see Proc. Ohio Acad. Sci., Vol. 8, Part 6, 1929. W. H. Bucher, Geology of Adams County. L. C. Hopkins, Collection of Pteridophytes.

1920. F. C. Blake, two grants for purchase of apparatus. Paul B. Sears, Ohio Vegetation. W. H. Bucher; L. B. Walton, Fresh Water Organisms. Elsie Jordan, continued in '21.

1921. Elsie Jordan, "Relabeling Harper Collection of Naiades" under Dr. Bucher. L. B. Walton, study of "Fresh Water Organisms," published as Ohio Biological Survey Bulletin No. 24, "Fresh Water Organisms in Water Supplies."

1922. Paul B. Sears, "Vegetation of Ohio." J. S. Hine, "Mammals of Ohio."

1923. L. B. Walton, Aquatic Organisms. F. H. Herrick, Eagle Nests at Vermillion, Ohio. L. H. Tiffany, collecting algae in Ohio. J. E. Kindred, aquatic studies in Puget Sound. E. L. Stover, underground parts of grasses. R. A. Dobbins, mosaic diseases of tomatoes. S. S. Humphrey, root and stem rots of clover.

1926. W. M. Barrows, for "publication of paper on structures of spiders."

1928. Bernard S. Meyer, "Study of Seasonal Variation in Leaves."

1934. W. L. Evans for Chemistry Dept., O. S. U., for apparatus.

1935. R. B. Frost, Lorain Urban Survey.

1936. J. P. Porter, Studies on Behavior of Spiders.

1937. D. C. Rife, Genetic Studies of Monozygotic Twins and other Multiple Births. Wayne M. Felts, On Acid Intrusive in Cascade Mountains of S. W. Washington. R. A. Dobbins, Vegetation of the Northern Virginia Military Lands of Ohio.

1938. G. D. Hubbard, "Abandoned Glacial Lakes in N. Ohio." F. H. Verhoek, Apparatus for Studies of Solvents.

1939. Grant to Dr. E. Lucy Braun, University of Cincinnati, for her research upon the Deciduous Forest Formation of Eastern United States. Largely spent in travel expenses. Grant to Bertil G. Anderson, Western Reserve University, Cleveland, Ohio, for construction of constant temperature chamber for various experiments, as for instance, duration of the embryonic period, duration of the instars, etc. Grant to Dr. C. A. Lawson, Wittenberg College, Springfield, Ohio, for research defined as "An attempt to determine mechanism of gene action in embryonic development, using the Aphid *Macrosiphum solanifolii*."

1940. Dr. John W. Frink, 424 Riddle Road, Cincinnati, Ohio, for research on the "Terraces of the Ohio River." Grant to Prof. Archie N. Solberg, Biological Laboratory, University of Toledo, Toledo, Ohio, of $50.00 for the making of slides for special work in his research, embryology of *Fundulus heteroclitus*.

1941. J. N. Wolfe, R. T. Wareham and H. T. Scofield, in 1941, with an additional grant later in 1941, for research defined as "Investigation of plant communities and measurement of microclimatic and edaphic conditions in a single valley in Hocking County, Ohio." The money was used for traveling expenses, photographic supplies and materials and tools for the construction of minor equipment. Drs. Wolfe, Wareham and Scofield are instructors in the Department of Botany, O. S. U. Continued in 1942 and 1943.

1942. Continued grant to Drs. Wolfe, Wareham and Scofield from A. A. A. S.

1943. B. S. Meyer, Mineral Nutrition of Russian Dandelion. Carl Venard, Mosquitoes of Ohio. Continuation of grant to Drs. Wolfe, Wareham and Scofield.

1944. Continuation of grants to B. S. Meyer and Carl Venard from A. A. A. S. Miss Alta Schrock, Oberlin, Pollen Content of Peat Bogs. Mr. Albert E. Hyder, Ecology of Bird Population in Hocking County. Dr. H. T. Gier, Athens, Reproductive cycles in foxes in southeastern Ohio.

The fund was designated as the Emerson McMillin Research Fund in earlier reports, and may have had an official designation later, but I have not located the record.

No payments on grants were made for the year 1914, 1924, 1925, 1927, 1929, 1930, 1931, and 1933. In some cases at least grants were made but the projects were not completed and the grants lapsed or were continued and paid in later years.

An allowance from the A. A. A. S. based on the members of the Academy who are also members of the A. A. A. S. has been received since 1930, and since 1937 this allowance has been allotted for research projects approved by the Trustees of the Research Fund, the A. A. A. S. specifying that such projects be approved also by their permanent secretary and the amounts expended within the year.

Projects which have been assisted from this source have been as follows. The subjects are listed above.

1937. Dr. D. C. Rife, Wayne M. Felts, R. A. Dobbins.
1938. Dr. G. D. Hubbard, Frank Verhoek.
1939. Dr. E. Lucy Braun.
1940. John W. Frink, Archie A. Solberg.
1941. Drs. J. N. Wolfe, H. T. Scofield, R. T. Wareham.
1942. Drs. Wolfe, Scofield and Wareham.
1943. Drs. Wolfe, Scofield and Wareham. Dr. B. S. Meyer. Dr. Carl Venard.

REGULATIONS FOR THE USE OF THE McMILLIN RESEARCH FUND

The McMillin Research Fund of the Ohio Academy of Science has been maintained through the generosity of Emerson McMillin and grants from this fund are made upon application to the Trustees of the Fund.

Applications for grants should include a statement of the subject to be investigated, the nature of the expenses to be covered, and in so far as practicable a list of the proposed items of expense in such a manner that the Trustees may determine the expenses and the allowance needed.

In rendering accounts it is desirable that an itemized statement be submitted showing the cost of apparatus or supplies used or, in case of traveling expenses, the localities visited, amounts of railroad fare, hotel and other expenses as incurred. Payments granted from this fund will, as a rule, be made only after the expenses have been incurred and upon receipt of detailed statement.

Apparatus, books, maps or material supplies not consumed during these investigations which may be secured with grants from this fund are to be the property of the Academy and after the investigation is completed should be accounted for to the Trustees or deposited with such officer of the Academy as the Trustees may direct.

It is expected that the results of such investigations will be published and if other means of publication are not available, the Trustees will try to assist in securing suitable publication.

....., *Chairman.*

The above is a statement of form for application, not followed rigidly. It was prepared I think by Dr. Mendenhall and was formally adopted by the Academy at the 28th Annual Meeting, May 30, 1918.

From Dr. Mendenhall's paper on McMillin read at the Ohio Academy meeting at Oberlin, March 31, 1923, he quotes McMillin:

"The research fund seems to have been pretty lively and doing work out of proportion to its size. The workers rather than the cash, probably are entitled to the credit."

Again: "The Academy needs to live centuries. I cannot, at most, live but a few years, much as I would like to be permanently established at Darlington."

From "Report of the Trustees of the Research Fund," Columbus, Ohio, April 1, 1925:

"We recommend that the income from $1,000.00 of the Research Fund be available each year for a grant to be known as the McMillin grant and which may be used either for the

assistance in some research problem or given as an award in recognition of some especially noteworthy contribution of some member of the Academy. That the balance of the Fund and income derived from it, shall be used or allowed to accumulate as the trustees may deem best in any particular year, it being understood that the Fund or any interest income shall in all cases be used for the encouragement of research either by grants for individual problems or for the publication of papers resulting from research."

From the By-Laws adopted at the Thirty-fifth Annual Meeting:

"Chapter VII—Research Fund

"1. *Sources of Fund.*—The Research Fund shall consist of moneys paid by the general public for publications of the Academy, of donations made in the aid of research, and of sums paid in commutation of dues according to By-Laws, Chapter I, Paragraph 1.

"2. *Donors.*—Donors to this fund, to the sum of twenty-five dollars or more, shall be entitled without charge, to publications subsequently appearing.

"3. *Endowment.*—The aim of the Academy shall be to accumulate a fund of which the income alone shall be used for the encouragement of research and for the publication of papers bearing upon the development of science in the state."

TRUSTEES OF RESEARCH FUND AND DATES OF SERVICE

E. L. Moseley	1899–1900
F. M. Webster (Chairman 1900–1901)	1899–1904
H. C. Beardslee	1900–1902
C. J. Herrick	1904–1906
J. H. Schaffner	1900–1905
W. R. Lazenby (Chairman 1901–1915)	1899 and 1901–1916
G. B. Halsted	1905–1908
Chas. Dury	1907–1908
E. L. Rice	1908–1914
Frank Carney	1910–1913
M. M. Metcalf	1913–1917
N. M. Fenneman	1914–1917
T. C. Mendenhall (Chairman 1916–1924)	1916–1924
Herbert Osborn (Chairman 1925–)	1917–date
M. E. Stickney	1917–1919
G. D. Hubbard	1919–1931, and 1934–1937
E. L. Rice	1924–1930
L. B. Walton	1930–1933
Alpheus Smith	1934–1936
W. L. Evans	1937–1939
J. P. Porter	1937–1940
C. G. Shatzer	1939–1942
Paul B. Sears	1941–1944
F. C. Blake	1942–1945

The Trustees named at the annual meeting, 1898, for the succeeding year were E. L. Moseley, F. M. Webster and W. R. Lazenby and were for *one year*. In 1899 members were named for one, two, and three years and F. M. Webster became chairman. He was chairman until 1901; W. R. Lazenby, 1901–1915; T. C. Mendenhall, 1916–1924; Herbert Osborn, 1925– .

The following papers published as special papers received assistance from the Research Fund. Special papers from three to nineteen were assisted by grants from Research Fund.

The Preglacial Drainage of Ohio—W. G. Tight, J. A. Bownocker, J. H. Todd and Gerard Fowke.
The Fishes of Ohio—Raymond Osburn.
Tabanidae of Ohio—James S. Hine.
Birds of Ohio—Lynds Jones.
Ecological Study of Big Spring Prairie—Thomas A. Bonser.
The Coccidae of Ohio—James G. Sanders.
Batrachians and Reptiles of Ohio—Max Morse.
Ecological Study of Brush Lake—J. H. Schaffner, Otto E. Jennings, Fred J. Tyler.
The Willows of Ohio—Robert F. Griggs.
Land and Fresh-Water Mollusca of Ohio—V. Sterki.
The Protozoa of Sandusky Bay and Vicinity—F. L. Landacre.
Discomycetes in the Vicinity of Oxford—Freda M. Bachman.
Trees of Ohio and Surrounding Territory—John H. Schaffner.
The Pteridophytes of Ohio—John H. Schaffner.

The Fauna of the Maxville Limestone—W. C. Morse.
The Agaricaceae of Ohio—W. G. Stover.
An Ecological Study of Buckeye Lake—Frederica Detmers.

The series of Special Papers was discontinued in 1929, but results of researches under these grants have appeared in the *Ohio Journal of Science*, The Ohio Biological Survey and in various other scientific journals.

I am indebted to Mrs. Ethel Melsheimer Miller for assistance in determining the subjects of researches for a number of the earlier projects.

If details were available an interesting story could be written about the grants that were made but for which no payments were made, due doubtless to the abandonment of the project or lack of reports.

Evolution of Man

This is the fifth title in a series of scientific books sponsored by the American Museum of Natural History. Professor Howells has done a magnificent job of bringing to the layman a highly readable account of the history of mankind. His free and easy style, and the dramatic treatment of the subject matter combine to make this book fascinating in all its details as well as its being authoritative.

There are twenty-five chapters which are organized into three parts. Part One leads the reader through a short discussion of the principles of evolution. Application of these principles are then made to the evolution of the vertebrate groups which have served as ancestral to man. In the second part the author discusses fossil men and their probable relationship to *Homo sapiens*. Enough history about these finds and the men who made them is included to heighten interest in this section. Part Three deals with the nature and origin of races, their migrations and geographical distribution. In the last chapter the author depicts some of the probable trends in man's evolution during the next one million years.—*W. M. Tidd.*

Mankind So Far, by William Howells, xii and 319 pages. Thirty-seven line-cut and halftone illustrations. Published by Doubleday, Doran and Company, Inc., Garden City, New York, 1944. $4.50.

Ticks of North America

This excellent monograph on argasid ticks contains the following sections: Introduction; Medical and Veterinary Importance of the Argasidae; Explanation of Terms; Principal Characters of Argasidae; Methods; Family Argasidae; Genus Argas; Genus Otobius; Genus Ornithodoros; Genus Antricola; Plates; Classified List of Hosts; Geographical Districation of Species; Bibliography; and Index.

The morphology of each species is thoroughly described and illustrated for all stages that have been recognized. The known distribution of each species is indicated by a map and information on hosts and biology is included in so far as it is available. The numerous illustrations are of high quality in that they are artistic in appearance and show diagnostic features.

Twenty-five species are recognized for the area covered and many people are already acquainted with some of them. Two bad pests are the blue bug of poultry in Florida, Texas and elsewhere, and the spinose ear tick of cattle in the West. Some species are vectors of disease and in this connection may be mentioned the relapsing fevers of the Western States and the experimental transmission of Rocky Mountain spotted fever.

The authors have produced a treatise which can be used by amateurs as well as by seasoned entomologists and therefore it can be predicted that their book will be the stimulus for much research and especially faunistic studies.

The American Midland Naturalist Monograph No. 1. The Argasidae of North America, Central America, and Cuba, by R. A. Cooley and G. M. Kohls. 152 pages, 57 text figures, 14 plates. The University Press, Notre Dame, Indiana, June, 1944. Price, $2.00.

DOLOMITES

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ABSTRACT

The origin of dolomite is a subject of much interest in Ohio as this state is underlain by great thicknesses of such rock, some of high purity. Within the last few years over 335 detailed analyses have been made. These analyses have been reduced by calculation to their mineral components, which treatment throws much light on the nature of the rocks and reveals certain inferences concerning the origin of both dolomite and limestone. From these studies dolomite was deposited in sea water with normal salinity and limestone in that diluted by fresh water from the land areas.

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INTRODUCTION

The groundwork for the following paper is as follows:

(a) The examination of a thick section of carbonate rocks in Ohio, Cambrian to Permian time.

(b) Much detailed work in identifying, sectioning and sampling the deposits.

(c) Careful appraisal of mineral components of over 400 high-grade chemical analyses of dolomites and limestones throughout the section.

(d) Use of some of the common chemical reactions involving carbonates.

(e) The aid of a few of the simple laws of thermo-chemistry.

(f) The chemistry of fresh and salt water as defined by Clark.

(g) The fact that the ocean is the only source for such a large supply of magnesium oxide, MgO, or rather atomic magnesium, Mg, in an active form as shown by Clark.

Some of the generalizations considered are as follows: Dolomites are the normal and most abundant deposits of carbonate rocks laid down in the ocean throughout the geological ages. In the limestones this compound, $CaMg(CO_3)_2$, also bears a rather conspicuous part. Many dolomites approach chemical purity, that is, they contain no or little limestone. Conversely the limestones are always more or less dolomitic in character. A detailed physical and chemical study of such rocks in Ohio[1] indicates that the dolomites are primary in origin, that is, they were deposited as found today. No alterations are apparent except very locally and

[1]See Bull. 42, Geological Survey of Ohio, also records in files.

then the change is more physical than chemical. Dolomites originated through chemical activity in sea water of normal concentration, either in shallow or deep water but largely under the former condition.

On the other hand, limestones, the less abundant carbonate rocks of the ocean, were deposited under marine conditions but where the normal salt solutions were somewhat diluted through the influx of fresh water from land sources. Thus limestones carrying a high content of calcium carbonate are usually in association with shale deposits, either above or below or within the formation. In general the shale materials originated on the land and were carried to the ocean by streams. The streams not only diluted the sea water but brought in large supplies of carbonic acid, CO_2 or H_2CO_3 and some soluble calcium bicarbonate salt, $Ca(HCO_3)_2$. In the great carbonate formations of the Mississippian, Devonian, Silurian, and Ordovician systems the limestone deposits are, with few exceptions, placed between shales. Further, the basal portion of such limestones, if thick, is much higher in dolomitic matter than the upper portion. In the Pennsylvanian and Permian systems in Ohio the carbonate strata of fresh water origin[2] and also those of marine derivation[3] are limestones with a low content of dolomites, $CaMg(CO_3)_2$. The fresh water limestones occur under, and the marine limestones over the coal beds which are known to have been deposited on land through humid conditions. Clays, shales, and sandstones are found as associate deposits. Such limestones, in the coal formations, are usually thin but widely spread in distribution.[4]

CHEMICAL NATURE OF CARBONATES

The carbonate rocks are built around the carbon atom, C, as the nucleus of the acid component. Through oxidation this carbon, C, changes to the oxide form, carbon monoxide, CO, or the dioxide, CO_2, most commonly the latter. Then through hydration, or the addition of water, carbon dioxide, CO_2, produces the unstable acid, H_2CO_3, and the acid salts of $H_2(HCO_3)_2$, as $Ca(HCO_3)_2$, $Fe(HCO_3)_2$, $Mg(HCO_3)_2$, $Mn(HCO_3)_2$, all soluble substances and carried in fresh waters. The changes may be given as follows:

$$\begin{array}{l} C \\ \downarrow \\ C+O_2=CO_2 \\ \qquad\quad \downarrow \\ \qquad\quad CO_2+H_2O=H_2CO_3 \text{ or } H_2(HCO_3)_2 \end{array}$$

Carbon is one of the original elements and in some form is widely distributed in nature. In this discussion carbon dioxide, CO_2, is the compound of most interest. At present, and in the past, most of the carbon dioxide in the air and in solution in fresh or saline waters is derived directly or indirectly from the decay or from the exhalation of organic matter, animal or vegetable, on the land surface, in fresh water or in the ocean. Those of most concern are the parts held in solution in both the fresh waters of the land areas and in the saline waters of the sea. Thus all the streams are pouring continuous supplies of carbon dioxide in some form into the ocean and the sea with the changing of its myriad organic forms, through life

---

[2]The fresh water limestones include the Salem, Lower Freeport, Upper Freeport, Mahoning, Bloomfield, Ewing, Elk Lick, Clarksburg, Summerfield, Pittsburgh, Redstone, Fishpot, Benwood, Arnoldsburg, Uniontown, Waynesburg, Elm Grove, Lower Washington, Middle Washington, Upper Washington, Nineveh and Gilmore members.

[3]The marine strata include Lowellville, Boggs, Lower Mercer, Upper Mercer, Putnam Hill, Zaleski, Vanport, Hamden, Brush Creek, Cambridge, Portersville, Ames, Gaysport and Skelley members.

[4]For the relations of coal, clay, fresh water and marine limestones, see Bull. 26, Fourth Series, Geological Survey of Ohio, pages 533-568.

and death, generates large amounts for chemical activity. In such ways carbon dioxide has been produced in greater or lesser quantities throughout the geological ages since life began, even in its most simple forms. Hence organic life appears to supply the needed quantity of carbon dioxide to complete the reactions for the precipitation of dolomites and limestones.

SOURCE OF COMPONENTS

The basic components, MgO or CaO or Mg and Ca, were supplied by the ocean with some augmentation from the land areas. Sea water even after the extraction of large quantities of magnesium for the formation of dolomites throughout the geological ages is still rich in that substance. According to Clarke[5] the salinity of the ocean varies from 3.301 to 3.737 per cent and the mean of seventy-seven analyses is as follows:

Cl	55.292
Br	.188
SO_4	7.692
CO_3	.207
Na	30.593
K	1.106
Ca	1.197
Mg	3.725
Total	100.000

Thus the quantity of magnesium is over 3.11 times that of the calcium and the reacting value of the former is 5.13 times that of the latter. Hence in any reaction in normal sea water, involving precipitation, magnesium will be the dominating component and dolomite and not limestone will be the resulting product.

Clarke states:[6] "In chemical character, fresh and salt waters are opposites, as a brief inspection of the data will show. In ocean water, $Cl > SO_4 > CO_3$; in average river water, $CO_3 > SO_4 > Cl$. So also for the bases—in the first case, $Na > Mg > Ca$; in the other, $Ca > Mg > Na$—a complete reversal of the order."

Commonly in nature the reaction that takes place in precipitation is the one involving the least exchange of heat or of energy used. The heats of formation of calcium carbonate and magnesium carbonate in the simple reactions, per unit of compound are as follows:[7]

Calcium carbonate, $CaO \cdot CO_2$	451 calories
Magnesium carbonate, $MgO \cdot CO_2$	349 calories

Then under such conditions with a preponderance of magnesium in the ocean waters, with a higher reacting value for the element, magnesium, with less heat exchange, and with less solubility in the salt solution, the precipitated compound, thus leaving the field of chemical activity, should be dolomite and not limestone. Here magnesium oxide, MgO, is the dominating base in such a solution and when this is allowed to react with the carbonic acid, $H_2(HCO_3)_2$ or the acid salt, $Ca(HCO_3)_2$, brought in from the land surface, the resulting product is dolomite. In fresh water, limestone and not dolomite would be the favored precipitate as the acid H_2CO_3 or $H_2(HCO_3)_2$ is abundant and as the base CaO is much in excess of MgO. The resulting products are those of simple precipitation.

In the waters from land areas both the acid and basic components are much different from those of marine waters and consequently the chemical activity of the former will be unlike in some respects from that of the latter. As an example

[5]Clarke, Frank Wigglesworth, Data of Geochemistry, Bull. 330, U. S. G. S., pages 94–95.

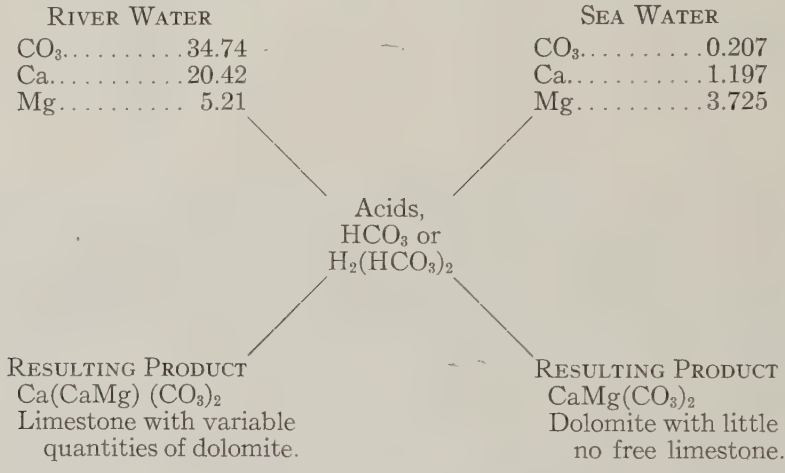
[6]Clarke, Frank Wigglesworth, Data of Geochemistry, Bull. 330, U. S. G. S., page 107.

[7]Richards, Joseph W., Metallurgical Calculations, Part 1, page 2020.

of surface water from the land areas that from the Mississippi River may be taken as representative.[8]

CO_3	34.74
SO_4	14.90
Cl	6.23
NO_3	1.57
Ca	20.42
Mg	5.21
Na	4.92
K	4.65
SiO_2	6.77
Al_2O_3	0.44
Fe_2O_3	.015

In this analysis of river water the Ca is 3.92 times the Mg which is far different from the proportions found in sea water. The content of CO_3 is also high; 34.74 for river water compared to 0.207 for sea water. Further it carries SiO_2, Al_2O_3 and Fe_2O_3 as soluble components. The direct comparison is as follows:



In fresh water the resulting product is a limestone with an appreciable but variable quantity of dolomite. Thus the reaction is not complete, yielding pure $CaCO_3$ or $CaCa(CO_3)_2$. However, in sea water, in the large majority of cases, the reaction reaches completion yielding $CaMg(CO_3)_2$, dolomite, with no free limestone and with the true chemical ratio. Under varying conditions mixtures of the two are common.

If dolomite is secondary, that is, first deposited as a limestone then changed to dolomite, much additional work would be involved in the reaction. This requires the solution of the originally precipitated limestone before the exchange of Mg for Ca could take place. Also other reactions would be involved in the adjustment. Such work would be done in a salt solution in which the Mg much exceeds the Ca and in which dolomite is evidently much less soluble than limestone as shown by the solution and disappearance of the shells of fossils in the dolomites, leaving only casts in the rock. The formation of dolomite in sea water is quite simple as "the monovalent ion HCO_3' is formed by preference, and to this some of the characteristic properties of the carbonates are due."[9] Some of these may be represented as follows: HCO_3', monovalent hydrocarbon ion; $Ca(HCO_3)_2$, soluble calcium bicarbonate and $CaMg(CO_3)_2$ dolomite.

[8]Clarke, Frank Wigglesworth, The Data of Geochemistry, Bull. 330, U. S. G. S., page 65.

[9]Oswald, Wilhelm, The Principals of Inorganic Chemistry, 1908, page 395.

DATA FROM OHIO

Let us see how this works out in the carbonate rocks of the past geological ages. In Ohio about 335 detailed analyses have been made of the dolomites and limestones in the Permian, Pennsylvanian, Mississippian, Devonian, Silurian and Upper Ordovician systems.[10] Further, some work but in less detail has been done on the rocks of the lower Ordovician and of the Cambrian systems. These analyses were computed to their mineral components, dolomite, $CaMg(CO_3)_2$; limestone, $CaCO_3$; and various other substances. These results are shown on page 224.

FRESHWATER LIMESTONES OF PENNSYLVANIAN AND PERMIAN SYSTEMS

In the coal formations, fresh water limestones make their appearance just under the Middle Kittanning coal of the Allegheny series of the Pennsylvanian system. From this place to the Duquesne coal, about the middle of the Conemaugh series, fresh water limestones are common below the coal beds and marine limestones above them. Above the Skelley limestone, or through the upper part of the Conemaugh series, through the Monongahela series of the Pennsylvanian system and then through the Washington and Greene series of the Permian system, all limestones present, and other strata also, are of fresh water origin. No marine influence is evident. Such strata are limestones in the sense that the dominating component in all cases is calcium carbonate, $CaCO_3$. However, dolomite, $CaMg(CO_3)_2$, is a constant component. In 18 analyses of five members, (Washington, Benwood, Fishpot, Redstone, Summerfield), the most prominent and best developed, the variation is from 3.44 to 24.77 per cent dolomite and the average content 18.01 per cent. The limestone component, $CaCO_3$, varies from 59.13 to 88.63 per cent and the shale and other incidental components from 5.49 to 22.39 per cent. Thus in the freshwater limestone formations the bases occur, as stated by Clarke, in the order $CaO > MgO$, followed by small amounts of K_2O, FeO, Na_2O, and MnO. The acid component, CO_2 or HCO_3', is dominant, with small additions of S_2, SO_4. and P_2O_5. In a way these formations may be considered types for strictly freshwater formations.

MARINE LIMESTONES OF THE PENNSYLVANIAN SYSTEM

In Ohio in the Pottsville, Allegheny and lower Conemaugh series of the Pennsylvanian system a number of marine limestones are present. These vary from a few inches to 20 feet or more in thickness but range commonly between 1 and 8 feet. Marine limestones, if present, occur directly or closely above the coal beds. This is true also of the fossiliferous shales of marine or brackish water origin. Throughout the Pottsville, Allegheny and lower Conemaugh series this repetition of marine or brackish water deposits above the coal beds occurs in 21 out of a total of 31 coals. The coal beds are of land origin as are also the underlying coal formation clays. Further, some of the shales and sandstones are thus derived. The marine limestones and fossiliferous shales were deposited when subsidence first carried down the carbonaceous land surface, on which had developed the clays and the coals, to such a level that inundation by sea water took place. They were thus laid down in shallow, relatively quiet and silt free waters at the close of the coal forming stages. Under such conditions the marine waters were certainly more or less diluted with fresh water as on the average the coal beds are repeated about every 21 feet in the column. The marine waters also had excellent opportunities for charges of carbonic acid, HCO_3', or $H_2(CO_3)_2$. Six of such limestone members

[10]Geological Survey of Ohio, Bull. 42, Dolomites and Limestones of Western Ohio and unpublished analyses of limestones in eastern Ohio.

FRESHWATER LIMESTONES

Name of Formation	Average Thickness in Feet	Number of Samples	Dolomite $CaMg(CO_3)_2$	Limestone $CaCO_3$	Argillaceous Siliceous and Other Impurities
PERMIAN SYSTEM					
Washington	9	1	3.44	88.63	7.93
PENNSYLVANIAN SYSTEM					
Benwood	37	2	9.99	76.04	13.97
Fishpot	32	10	24.77	59.13	16.10
Redstone	13	2	15.33	62.28	22.39
Summerfield	12	3	7.46	87.05	5.49

MARINE LIMESTONES

PENNSYLVANIAN SYSTEM					
Ames	1½	5	3.40	86.22	10.38
Cambridge	4	3	3.19	58.12	38.69
Brush Creek	20	2	3.80	33.04	63.16
Vanport	6	7	2.61	90.59	6.80
Putnam Hill	4	16	4.49	88.72	6.79
Lower Mercer	2	5	4.64	86.77	8.59
MISSISSIPPIAN SYSTEM					
Maxville	20	5	19.83	70.38	9.79
DEVONIAN SYSTEM					
Delaware	45	12	30.46	55.81	13.73
Columbus —top	50	20	29.00	67.96	3.04
—bottom	40	24	84.72	11.69	3.59
Lucas	50	6	86.30	9.50	4.20
Amherstburg	15	1	83.23	14.23	2.54
SILURIAN SYSTEM					
Monroe	570	85	93.90	2.34	3.76
Guelph-Cedarville	170	64	98.02	0.20	1.78
Springfield-West Union	20	21	84.40	3.13	12.47
Euphemia	6	3	96.55	0.76	2.69
Laurel	6	3	78.78	12.85	8.37
Dayton	8	5	70.01	17.20	12.79
Brassfield	27	17	22.29	72.23	5.48
Elkhorn	63	1	25.10	1.75	73.15
ORDOVICIAN SYSTEM					
Upper Part					
Richmond	265	1	10.69	66.47	22.84
Maysville	205	4	4.33	47.89	47.78
Eden	245	2	7.88	45.05	47.07
Utica	170	2	13.22	23.60	63.18
Trenton	185	1	12.57	74.84	12.59
Black River	425	2	14.14	79.83	6.03
Glenwood	10	1	22.99	4.04	72.97
ORDOVICIAN SYSTEM[11]					
Lower Part					
LOWER MAGNESIAN[12]	450	24	95.00	1.00	4.00
CAMBRIAN SYSTEM[13]	715	52	54.49	0.81	44.70

[11]Partial analyses and microscopic work show dolomite with high purity.

[12]Partial analyses and microscopic work show dolomite with high purity.

[13]Partial analyses and microscopic work show dolomite with fair purity, cut by many sandstone strata.

Crystalline rocks, mainly gneiss.

(Ames, Cambridge Brush Creek, Vanport, Putnam Hill, Lower Mercer) were sampled, 38 tests in all being made. In these the dolomite component $CaMg(CO_3)_2$, is quite low, varying from 2.61 to 4.49 per cent and averaging 3.89 per cent. The deposits are thus rich in limestone, $CaCO$, the common range being between 50 and 90 per cent. Further, they are variable but generally low in argillaceous, siliceous and other impurities. Hence they conform to deposition in diluted marine waters where the acid, HCO_3', or $H_2(HCO_3)_2$, was abundant and the bases largely supplied directly or indirectly from land sources.

MAXVILLE FORMATION

The Maxville formation of the Mississippian system is patchy in development in Ohio. Thus the deposits are broken, more or less scattered and variable in thickness. A break or unconformity is present both at the top and at the bottom of the formation. The thickness varies from 1 to 140 feet or more. It is of marine origin as shown by the fossils which, however, are not abundant and are confined largely to the shaly partings along the bedding planes. In general this limestone is finely crystalline, dense and hard. The underlying formations, 300 to 600 feet or more in thickness, are the shales, sandstones and conglomerates, all of marine origin but chiefly of land derived materials. In Ohio the upper, much worn and eroded surface of the Maxville formations is in contact with the Pottsville rocks of the Pennsylvanian system. The lost interval here represents the Mauch Chunk of the Appalachian Mountains area. In Ohio, where thick, the upper part of the Maxville formation is a limestone rich in calcium carbonate, $CaCO_3$, low in dolomite, $MgCO_3 \cdot CaCO_3$, and generally low in the common impurities. This part is used in the manufacture of Portland cement. However, the lower portion is quite dolomitic in character, being classed as a limey dolomite. In five samples, from top to bottom, the range of components is, dolomite, $CaMg(CO_3)_2$, 1.84 to to 72.81 per cent and limestone, $CaCO_3$, 4.18 to 95.25. The respective averages are 19.83 per cent for the former and 70.38 per cent for the latter. The lower portion thus shows the influence of marine conditions not far from land areas and the upper portion bears more toward shallow marine conditions in advance of the coal formation stages.

DELAWARE FORMATION

The Delaware formation in Ohio varies from 30 to 70 feet in thickness but averages close to 45 feet. It is a limestone, dark gray to dark with carbonaceous pigments, rather dense in character, often flinty and commonly rich in marine fossils. It is overlain directly by the Olentangy shale and this in turn by the Ohio shale rich in organic matter. The total shale covering is thus several hundred feet of land derived materials. The Delaware formation is underlain locally by the Marcellus shale, much like the Ohio in character, that is, black and carbonaceous but otherwise of land derived materials. Along much of the outcrop the Delaware lies unconformably on the Columbus formation. From 12 analyses, spaced over a wide area the Delaware should be classed as a dolomitic limestone of only moderate purity. On the average the dolomite component, $CaMg(CO_3)_2$, is 30.46 per cent, the limestone component, $CaCO_3$, is 55.81 per cent and the siliceous, argillaceous and other ingredients are 13.73 per cent. In these analyses the minimum and maximum figures are, dolomite, $CaMg(CO_3)_2$, 14.21 and 52.83 per cent and the limestone, $CaCO_3$, 35.73 and 78.16. The composition thus indicates that the formation was laid down in sea water somewhat diluted by fresh water which was rich in the acid, HCO_3' and contained bases in the proportion of $CaO > MgO$.

COLUMBUS FORMATION, UPPER PART

The upper part of the Columbus formation, from 50 to 60 feet in thickness, and made up of the Klondyke and Coral members in central Ohio and the Venice and Marblehead in northern Ohio, is consistently a limestone, light to light gray in color, rich in fossils and earthy to dense crystalline in texture. It is overlain by the Marcellus black shale or by the disconformity marking the stratum. On the other hand the basal portion of the Columbus formation is a dolomite with a small content of limestone, $CaCO_3$. Wherever tested the upper portion shows a distinct gradation downward in the content of $MgCO_3$. For example at Columbus the figures are:

	Thickness	$MgCO_3$	$CaCO_3$
	ft. *in.*		
Sample 241, top	14 3	5.19	91.99
242	11 3	10.90	86.76
243	16 6	12.88	84.98

At the O'Shaughnessy Dam in Delaware County the results are:

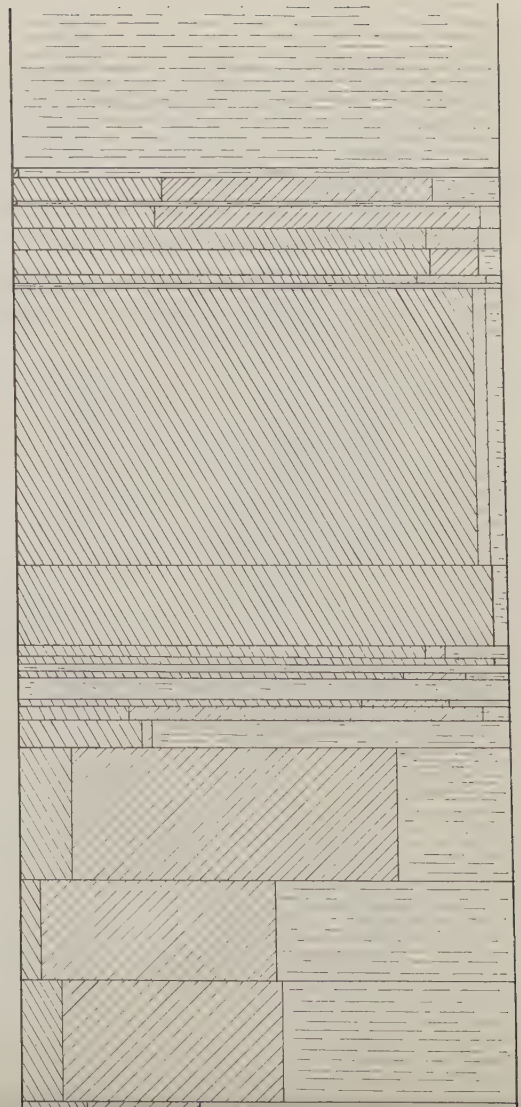
	Thickness	$MgCO_3$	$CaCO_3$
	ft. *in.*		
Sample 209 Klondyke, top member	22 0	7.32	90.13
207 Coral	23 7	11.31	86.33
206 Eversole	10 1	28.44	61.08
208 Bellepoint	14 4	39.90	58.04

In general the upper part of the Columbus formation must be classed as a limestone, always somewhat dolomitic in character and rather low in the common impurities. In 20 samples taken across Ohio the dolomite component, $CaMg(CO_3)_2$, varies from 9.23 to 66.91 per cent and averages 29.00 per cent. The limestone component, $CaCO_3$, runs as low as 26.88 per cent and as high as 89.75 per cent. The common impurities average about 3.04 per cent. Thus the data would indicate that the upper portion of the Columbus formation was laid down in marine waters, slightly diluted with fresh water bearing little sediments.

COLUMBUS FORMATION, LOWER PORTION

The lower portion of the Columbus formation, 20 to 50 feet in thickness, imparts a different story as far as origin is concerned. It is usually slight brownish gray to light brown in color, definitely crystalline in texture, impoverished in fossils, then only casts, and locally impregnated with chert. It is directly overlain, with only a bedding plane for parting, by the upper portion of the Columbus formation and underlain by formations of the Detroit River group or by the disconformity marking the absence of a thick section of such rocks. Rather commonly the Columbus formation rests on the Monroe dolomite. Little or no land derived sediments are found within basal Columbus rocks or are found associated in the older formations. They are marine in origin with little influence from fresh water changes. From 24 samples gathered over a wide area in western Ohio and representative of the formation the dolomite component, $CaMg(CO_3)_2$, varies from 44.17 to 97.27 per cent and averages 84.72 per cent. On the other hand the free limestone, $CaCO_3$, varies from 0.00 to 53.72 per cent and averages only 11.69 per cent. The two carbonates make up all but 3.59 per cent of the total. Such rocks were laid down by precipitation in sea water closely normal in concentration.

OHIO	SHALE	600	5	0.00	0.00	100.00
OLENTANGY	SHALE	20	2	0.00	1.00	99.00
DELAWARE	LIMESTONE	45	12	30.46	55.81	13.73
MARCELLUS	SHALE	10		0.00	1.00	99.00
COLUMBUS TOP	LIMESTONE	50	20	29.06	67.96	3.04
BOTTOM	DOLOMITE	40	24	84.72	11.69	3.59
LUCAS	DOLOMITE	50	6	86.30	9.50	4.20
AMHERSTBURG	DOLOMITE	15	1	83.23	14.23	2.54
ORISKANY	SANDSTONE	10				
SILURIAN SYSTEM						
MONROE	DOLOMITE	570	85	93.90	2.34	3.76
GUELPH-CEDARVILLE	DOLOMITE	170	64	98.02	0.20	1.78
SPRINGFIELD	DOLOMITE	20	21	84.80	3.13	12.47
EUPHEMIA	DOLOMITE	6	3	98.55	0.79	2.09
MASSIE	SHALE	5				
LAUREL	DOLOMITE	8	3	78.78	12.85	8.37
OSGOOD	SHALE	45				
DAYTON	DOLOMITE	8	5	70.01	17.20	12.79
BRASSFIELD	LIMESTONE	27	17	22.29	72.23	5.48
ELKHORN	SHALE	63	1	25.10	1.75	73.15
ORDOVICIAN SYSTEM						
RICHMOND	SHALE AND LM.	265	1	10.69	66.47	22.84
MAYSVILLE	SHALE AND LM.	205	4	4.33	47.88	47.78
EDEN	SHALE AND LM.	245	2	7.88	45.05	47.07



TRENTON	LIMESTONE	185	1	12.57	74.84	12.59
BLACK RIVER	LIMESTONE	425	2	14.14	79.83	6.03
GLENWOOD	SHALE AND DOLOMITE	10	1	22.99	4.04	72.97
LOWER MAGNESIAN	DOLOMITE	450		95.00	1.00	4.00

CAMBRIAN SYSTEM

CAMBRIAN	DOLOMITE	715		54.49	0.81	44.70

CRYSTALLINE ROCKS

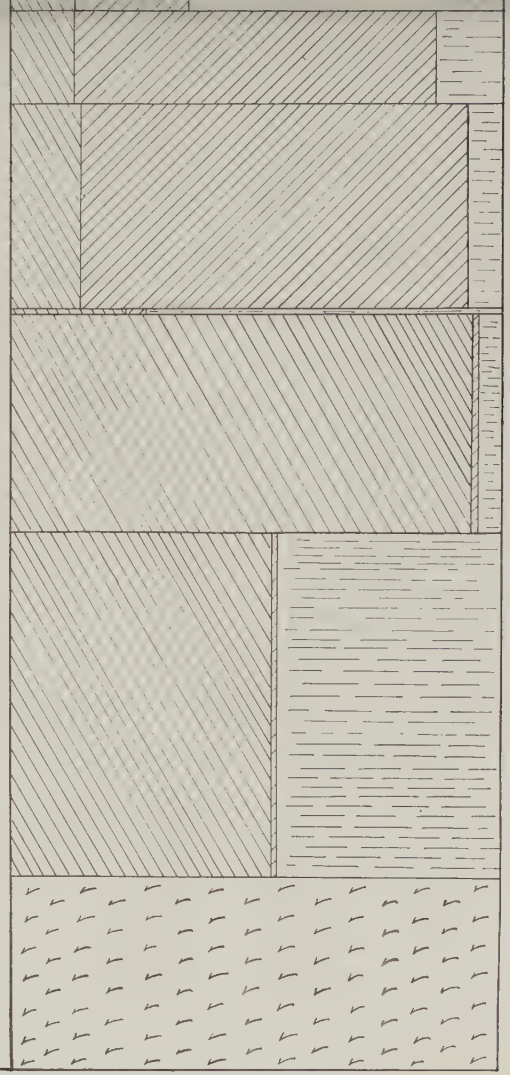
LEGEND

DOLOMITE

SHALE & ETC.

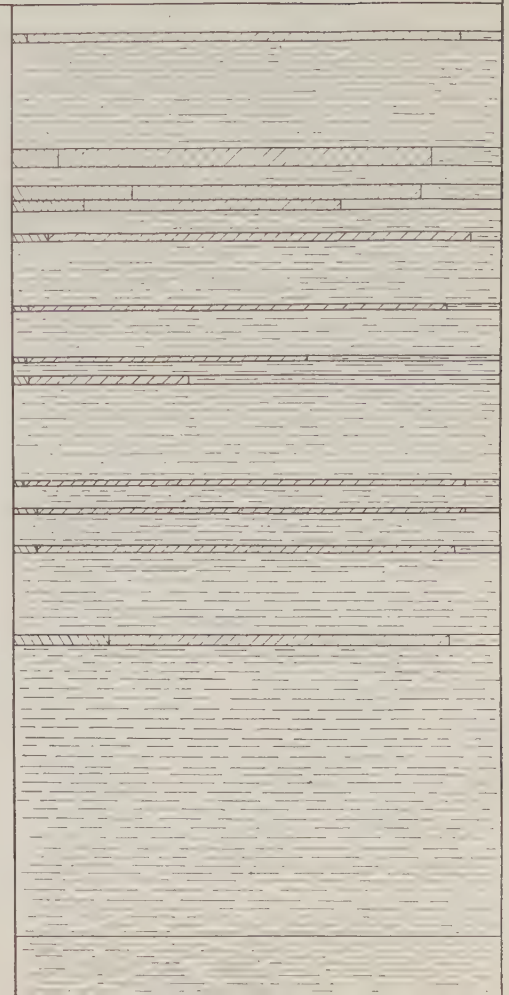
LIMESTONE

CRYSTALLINE



OHIO SECTION TO SCALE WITH COMPOSITION

FORMATION	MATERIAL	THICKNESS FEET	NO. OF SAMPLES	DOLOMITE $CaMg(CO_3)_2$	LIMESTONE $CaCO_3$	IMPURITIES
PERMIAN SYSTEM						
WASHINGTON	FRESH WATER IM	9	1	3.44	88 63	7.93
PENNSYLVANIAN SYSTEM		227				
BENWOOD	FRESH WATER IM.	37	2	9 99	76 04	13.97
		45				
FISHPOT	FRESH WATER IM	32	10	24 72	59 13	16 10
REDSTONE	FRESH WATER IM	15	2	15 39	62 28	32.39
		57				
SUMMERFIELD	FRESH WATER IM	2	3	7 46	87 05	5 49
		140				
AMES	MARINE IM.	2	5	3 40	86 22	10.38
		95				
CAMBRIDGE	MARINE IM	4	3	3. 19	58 12	38 69
		29				
BRUSH CREEK	MARINE IM	20	2	3 80	33 04	63. 16
		204				
VANPORT	MARINE IM.	5	7	2 61	90.59	6.80
		53				
PUTNAM HILL	MARINE IM.	4	18	4 49	88 72	6.79
		80				
LOWER MERCER	MARINE IM.	2	5	4. 64	86.77	8.59
MISSISSIPPIAN SYSTEM		75				
MAXVILLE	MARINE IM	20	5	29. 83	70 38	9.79
WAVERLY						
SUNBURY	SHALE AND SANDSTONE	655	10	0 00	0. 00	100.00
BEREA						
BEDFORD						
DEVONIAN SYSTEM						



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LUCAS FORMATION

In Ohio the Lucas formation is local in distribution and is confined to an outcrop in western Lucas, northwestern Wood and southeastern Henry counties. The thickness is erratic, the maximum given being about 140 feet. The Lucas is characteristically a dolomite but locally becomes calcareous in composition.

The formation is rather definitely bedded, the layers commonly ranging from 3 to 12 inches in thickness. The stone varies from light bluish gray to light brown or drab in color. Disconformities exist both at the top and at the bottom of the formation but in any event the underlying and overlying strata are dolomites and not limestones. From 6 representative analyses the dolomite component, $CaMg(CO_3)_2$, varies from 53.68 to 97.93 per cent and averages 86.30 per cent. The limestone component, $CaCO_3$, ranges from 0.00 to 44.90 per cent but averages 9.50 per cent. The stone is moderately high in purity as the two carbonate components make up all but 4.20 per cent of the total. Both the geological and chemical data suggest that the Lucas formation was deposited under marine conditions with only slight local modifications from land influence.

AMHERSTBURG FORMATION

The lower formation, the Amherstburg, of the Detroit River group, in Ohio, is confined to two areas, one east of the Cincinnati arch in Ottawa, Erie and Sandusky counties and another west of this structure in Lucas, Wood and Henry counties. The rock is a dolomite in composition, slight drab to brownish gray in color, open or even cavernous in texture and usually massive in bedding. The thickness where best developed appears to vary between 50 to 75 feet. It is overlain mainly by the Lucas formation, a dolomite, and underlain by the Oriskany sandstone or by the disconformity marking this stratum. Commonly the underlying formation is the Monroe, strictly a dolomite in composition. The one analysis for the Amherstburg shows, dolomite, $CaMg(CO_3)_2$, 83.23 per cent, limestone, $CaCO_3$, 14.23 per cent and impurities 2.54 per cent. The lenticular and patchy nature of the deposits suggests marine origin with slight land influence.

MONROE FORMATION

The Monroe formation in Ohio includes the Greenfield, Tymochtee, Put-in-Bay and Raisin River divisions which, however, are not definitely separated one from another and are very similar in geological, physical and chemical features. Here these four members are treated as one formation. The thickness of these rocks varies from 400 to 700 feet and averages about 570 feet. They may present a shelly, very thin, thin, medium or massive structure. Such variations may be found in almost any quarry face or throughout any considerable part of the entire section. In general the materials are slightly siliceous in character, the free silica content being a rather distinguishing element. The color range is wide but in general the tints exhibited are some shades of brown or dark bluish gray. In texture the stone changes from hard and dense to open, sugary or even cavernous. Parts are very definitely laminated through the effects of thin papery partings of dark-colored matter which suggests the concentration of organic scums during dry land periods. Breccias, mud cracks and ripple marks are common impressions In the Monroe dolomites the fossils are not abundant, are small in size, and are usually preserved as casts. The anhydrite and gypsum deposits of central and northern Ohio and the salt beds, over 7,000 square miles, throughout the eastern part of the State are ordinarily present about midway in the section. The data are definite and conclusive and shows deposition in normal or even concentrated sea water under shallow water condition. During many times the basin became mud flats exposed to the sun. In no way is alteration, substitution or secondary changes

evident. The material was deposited as dolomite. The Monroe is overlain by the Oriskany sandstone or if this is not present by some dolomite formation, and underlain by the great Guelph-Cedarville dolomite also of high purity.

The Monroe formation in Ohio was thoroughly examined and sampled throughout its entire exposed range in the western part of the state. In an average of 85 samples the components are dolomite, $CaMg(CO_3)_2$, 93.90 per cent; limestone, $CaCO_3$, 2.34 per cent and impurities 3.76 per cent. In 42 of these samples the free limestone, $CaCO_3$, ranged from 0.00 to 0.10 per cent and in 24 others from 0.10 to 0.25 per cent. The only ones showing any considerable amounts of free limestone were in south-central Ohio abutting the area of overlap where the underlying Niagara limestone was a land surface through upper Silurian and lower Devonian time. Here in a small area the rock becomes a dolomitic limestone. Aside from this the Monroe conforms strictly to direct deposition as a dolomite, close to the true chemical ratio. It was laid down as a primary deposit in shallow marine waters, generally normal or above in saturation.

GUELPH-CEDARVILLE FORMATION

The Guelph-Cedarville formation of the Niagara group covers a wide area in Ohio. In southern and southwestern Ohio such rocks are exposed in sixteen counties and in the north-central part of the area in eight counties. The thickness varies from 80 to 200 feet. The rock is highly crystalline, usually open and porous in texture, nearly white, light gray or bluish gray in color and always of high purity. The formation is massive in structure, thick faces often showing few if any well-defined partings. In local areas some chert appears in the lower portion in 5 to 25 feet of strata. The rock is everywhere a true dolomite, at or very close to the dolomitic ratio. The Guelph-Cedarville formation is overlain by the Monroe dolomite and underlain by the Springfield-West Union dolomite, another division of the Niagara group. Throughout the area of outcrop the Guelph-Cedarville formation was carefully sampled for testing, in all 65 samples were taken and tested. The average of these show, dolomite, $CaMg(CO_3)_2$, 98.02 per cent; limestone $CaCO_3$, 0.20 per cent and impurities 1.78 per cent. Of these, 42 samples had a free limestone content, $CaCO_3$, of 0.10 per cent or less and only 6 had quantities above 0.50 per cent. In the true Guelph of northern Ohio the average content of silica, SiO_2, is about 0.16 per cent and that of alumina, Al_2O_3, is not more than 0.05 per cent. The minimum recorded is 0.05 SiO_2 and 0.02 Al_2O_3. In the Cedarville of southern Ohio these components average close to 0.54 SiO_2 and 0.13 Al_2O_3. Such contents of silty materials certainly show these seas had little contact with land areas. The Guelph-Cedarville formation is thus a dolomite of exceptionally high purity, with little or no free limestone, $CaCO_3$, and evidently deposited under true marine conditions.

SPRINGFIELD-WEST UNION FORMATION

A definite group of strata of lenticular character near the base of the Niagara series is termed the Springfield-West Union formation. These deposits outcrop over a rather wide area in southwestern Ohio, vary in thickness from 10 to 40 feet and in general are dolomites somewhat siliceous in composition. They are directly overlain by the great Guelph-Cedarville formation and underlain by a series of calcareous shales and thin dolomites. The formation was carefully sampled throughout the area. In 21 samples the average components are: dolomite, $CaMg(CO_3)_2$, 84.40 per cent; limestone, $CaCO_3$, 3.13 per cent and impurities 12.47 per cent. The free limestone, $CaCO_3$, varies from 0.10 to 18.14 per cent and commonly—in 14 of 21 samples—ranges between 1.00 and 5.00 per cent. These analyses thus show a tendency towards slight dilution of the sea water or influence from land areas.

EUPHEMIA FORMATION

The Euphemia formation is the basal portion or a lens-like stratum of the great mass of Niagara dolomites. The rock is massive, porous and more or less mottled and commonly rich in fossils, preserved mainly as casts. The formation is relatively thin, averaging only about 6 feet. The outcrop of the member is confined to five counties. Three samples show the following average components: dolomite, $CaMg(CO_3)_2$, 96.55 per cent; limestone, $CaCO_3$, 0.76 per cent and impurities 2.69 per cent. The range of free limestone, $CaCO_3$, is from 0.00 to 2.24 per cent. The deposits are thus of marine origin in sea water close to normal in concentration.

LAUREL FORMATION

The Laurel formation is a thin, rather local unit, bedded in the calcareous shales, underlying the great body of Niagara dolomite. It is directly overlain by the Massie shale and underlain by the Osgood shale, both of which are made up largely of much land derived sediments. The rock is finely crystalline, dense and hard, is bluish gray in color and somewhat fossiliferous. Three analyses, relatively representative, furnish the following data on components: dolomite, $CaMg(CO_3)_2$, 78.78 per cent, limestone 12.85 per cent, and impurities 8.37 per cent. Its interbedding in shales, free limestone and moderate impurities all indicate influence from fresh water from land areas.

DAYTON FORMATION

The basal formation of the Niagara group is the Dayton member. It is directly overlain by the Osgood shales and underlain, with a slight disconformity, by the Brassfield limestone. The deposits are thin, varying from 7 to 13 feet and averaging only about 8 feet. The stone is thin bedded, compact, tough, crystalline and fossiliferous. In composition it is commonly a siliceous, limy dolomite. The results of five determinations are as follows: dolomite, $CaMg(CO_3)_2$, 70.01 per cent; limestone, $CaCO_3$, 17.20 per cent and impurities 12.79 per cent. The variation in dolomite is from 68.14 to 73.21 per cent and in limestone from 15.40 to 20.01 per cent.

A study of the preceding formations shows an increase downward in the quantity of free limestone, $CaCO_3$, and in the quantity of shale sediments for example:

	Dolomite $CaMg(CO_3)_2$	Limestone $CaCO_3$	Impurities
Guelph-Cedarville formation	98.02	0.20	1.78
Springfield-West Union formation	84.40	3.13	12.47
Euphemia formation	96.55	0.76	2.69
Laurel formation	78.78	12.85	8.37
Dayton formation	70.01	17.20	12.79

Thus the shift is from dolomites towards limestones which are the predominating rocks in the great mass of shales several hundreds of feet in thickness in the basal portion of the Silurian and in the upper part of the Ordovician systems. Hence the shift is from normal marine waters toward that diluted by fresh water from the land surfaces.

BRASSFIELD FORMATION

The Brassfield limestone in the lower part of the Silurian system is, in a way, placed out in a shale section and is a dolomitic limestone of fair purity. It is underlain by the Elkhorn or Red Medina shale and this in turn by that shale-limestone series of the Cincinnati group, in all about 900 feet in thickness. The Brassfield formation thus shows the influence of land or fresh water conditions.

The Brassfield member is from 20 to 40 feet in thickness and averages about 30 feet. It varies laterally from massive strata to thin bedded layers with shale partings. In color it ranges from a very light gray, nearly white, through darker shades of gray, buff and pink to brownish red. Marine fossils are abundant, being most concentrated along the partings. In composition the formation gradates downward from a relatively pure limestone at the top to one decidedly dolomitic at the bottom. This relationship is shown below:

Sample Number	Thickness		$MgCO_3$	$CaCO_3$	Dolomite $CaMg(CO_3)_2$	Limestone $CaCO_3$	Impurities
	ft.	*in.*					
275	9	4	3.35	95.86	7.33	91.88	0.79
274	9	5	15.25	83.94	33.35	65.84	0.81
273	6	9	20.75	78.23	45.38	53.60	1.02

The average of 17 samples representing all parts of the formation along its entire outcrop in southwestern Ohio yields the following: dolomite component, $CaMg(CO_3)_2$, 22.29 per cent; limestone component, $CaCO_3$, 72.23 per cent and impurities 5.48 per cent. The range in dolomite, is from 3.30 to 81.85 per cent and in limestone, from 9.37 to 91.88 per cent. Thus during the deposition of the Brassfield formation the conditions were variable but always were more or less influenced by fresh water from the land areas.

ELKHORN OR RED MEDINA FORMATION

The Elkhorn shale of Ohio is the Red Medina of the driller and the Queenstown of the New York section. It is regional in distribution but variable in thickness. In Ohio, it ranges from 10 to 250 feet but averages not far from 60 feet. The Elkhorn member is a typical shale in character but locally contains sandy lenses and limy matter. The color of the drill cuttings is distinctive, being red or brownish red. In composition it is classed as a siliceous, dolomitic shale rich in potash K_2O, and in hematite, Fe_2O_3. The testing of one sample from an oil well gave the following results:

Sample Number	Thickness		$MgCO_3$	$CaCO_3$	Dolomite $CaMg(CO_3)_2$	Limestone $CaCO_3$	Impurities
	ft.	*in.*					
219	56	0	11.48	15.37	25.10	1.75	73.15

The analysis shows that the Elkhorn is a shale, argillaceous, ferruginous and siliceous from land derived components and dolomitic from marine components.

RICHMOND, MAYSVILLE AND EDEN FORMATION

The Richmond is the upper formation of the Cincinnati group of the Ordovician system and is closely similar in every respect to the underlying Maysville and Eden formations. All are made up of great series of shales and limestone laid down with little alteration of the physical conditions. They were deposited in marine water, most certainly modified as to concentration. Here shale and limestone are repeated in rapid succession through a great thickness, 700 feet, of strata.

The deposits of the three formations are made up of alternate layers of shale and limestone, generally sharply defined but rather uniformly spaced. The hard carbonate rocks form from 20 to 50 per cent of the whole. These limestone strata range from 1 inch or less to 10 inches in thickness and are interbedded with the

shale, always calcareous in nature. The shale partings are on the average somewhat thicker than the limestone layers. The compositions of these formations as shown by a few analyses are given below:

	Thickness, feet	$MgCO_3$	$CaCO_3$	Dolomite $CaMg(CO_3)_2$	Limestone $CaCO_3$	Impurities, Shale, etc.
Richmond						
Stone and shale	265	4.89	72.27	10.69	64.47	22.84
Maysville	205					
Stone		1.61	83.26	3.52	81.35	15.13
Shale		2.40	14.53	5.25	11.68	83.07
Stone		2.20	85.62	4.81	83.01	12.18
Shale		1.72	17.54	3.76	15.50	80.74
Eden	245					
Stone		2.32	82.26	5.07	79.51	15.42
Shale		4.89	16.39	10.69	10.59	78.72

In composition these limestones closely duplicate the marine limestone of the Pennsylvanian system or of the coal formations. The bases conform to land or fresh water origin where the $CaO > MgO$. The associated shales are slightly more dolomitic in character. This rapid succession of shale-limestone, shale-limestone, repeated hundreds of times may be accounted for by seasonal inundations from the land areas which thus brought in greater supplies of bases, $CaO > MgO$, at each particular time. In a way it is comparable to the conditions in the Pennsylvanian system where inundations of the coal swamps, with diluted marine waters, gave rise to limestones or fossiliferous calcareous shales. Every coal bed in the Pottsville series and most of them in the Allegheny and lower Conemaugh series are directly or closely overlain by a marine limestone or fossiliferous shale. The end results in both cases, Cincinnatian and Pennsylvanian, are closely alike.

UTICA FORMATION

In Ohio, as detected by the drill, this formation ranges from 25 to 400 feet in thickness but averages close to 300 feet. It consists of calcareous, carbonaceous shales and shaly limestone, the latter being most concentrated in the lower portion. In color the Utica is conspicuous, ranging from brown to black, quite similar to the Marcellus, Ohio and Sunbury shales. The composition is shown below:

Sample Number	Thickness in Feet	$MgCO_3$	$CaCO_3$	Dolomite $CaMg(CO_3)_2$	Limestone $CaCO_3$	Shale, etc.
216	310	4.47	21.75	9.77	16.45	73.78
217	16	7.63	39.80	16.68	30.75	52.57

The organic nature of the coloring pigment is shown by the presence, in sample No. 216, of 0.33 per cent hydrocarbons, C_nH_{2n+2}. Both the organic matter, the shale component and the composition show the influence of land masses.

TRENTON AND BLACK RIVER FORMATIONS

The Trenton and Black River formations, commonly designated Trenton by the driller, make up a thick mass of carbonate rocks, averaging over 600 feet in thickness, which extends regionally across the state. These rocks are dark gray to dark in color, generally fine and dense in texture and vary from dolomitic limestones to true dolomites in composition. Where tested in the southwestern and central parts of Ohio they are limestone but in the northwestern part, in the old

Lima oil field, they are open, porous dolomites. The three analyses following are from the limestone area.

Sample Number	Thickness in Feet	$MgCO_3$	$CaCO_3$	Dolomite $CaMg(CO_3)_2$	Limestone $CaCO_3$	Impurities
Trenton						
220	185	5.75	81.66	12.57	74.84	12.59
Black River						
221	149	6.57	85.76	14.37	77.96	7.67
222	272	6.36	89.26	13.91	81.71	4.38

The composition of the Trenton and Black River formations indicates that these rocks were laid down in the sea where the conditions of salinity shifted, commonly depositing dolomitic limestone but more locally yielding dolomite.

LOWER ORDOVICIAN AND CAMBRIAN SYSTEMS

In Ohio where tested by the drill the rocks from the St. Peter sandstone of the Ordovician system through the Cambrian to the crystalline rocks of pre-Cambrian age are essentially dolomites and sandstone, the latter bedded in the former. From one set of 76 rough analyses the composition may be approximated about as follows:

	Thickness in Feet	Dolomite $CaMg(CO_3)_2$	Limestone $CaCO_3$	Sand and Other Impurities
Ordovician System				
Lower Magnesian	450	95.00	1.00	4.00
Cambrian System				
Upper part	580	66.00	1.00	43.00
Dresbach	135	5.00	0.00	95.00
Total	715	54.49	0.81	44.70
Crystalline rocks.				

The composition thus indicates normal marine deposits where the bases stand $Na > Mg > Ca$ and the acids $Cl > SO_4 CO_3$.

CONCLUSIONS

A summary of the results of the composition of the carbonate rocks in the entire section in Ohio from the crystalline rocks through the Cambrian, Ordovician, Silurian, Devonian, Mississippian, Pennsylvanian and Permian systems to the unconsolidated recent materials is as given below:

Geological System	Thickness of Rock Tested	Dolomite Component $CaMg(CO_3)_2$ in per cent	Limestone Component $CaCO_3$ in per cent	Shale and Other Impurities in per cent
Permian	9	3.44	88.63	7.93
Pennsylvanian	131½	12.08	65.81	22.11
Mississippian	20	19.83	70.38	9.79
Devonian	200	58.86	35.33	5.81
Silurian	870	86.98	4.26	8.76
Ordovician				
Upper	1,505	10.94	60.00	29.06
Lower	450	95.00	1.00	4.00
Cambrian	715	54.49	0.81	44.70
Total	3,900½	48.10	28.96	22.94

Thus in the 3,900 feet of tested carbonate materials in a total section of 6,796 feet the dolomite component, $CaMg(CO_3)_2$, stands in the ratio to the limestone component, $CaCO_3$, of 48.10 to 28.96 or approximately about 5 to 3. The data show that the Silurian, lower Ordovician and Cambrian carbonate rocks are nearly entirely true dolomites. In the Devonian system the quantity of dolomite much exceeds that of limestone. In all of these true marine conditions of deposition prevailed. However, in the Permian, Pennsylvanian, Mississippian and Upper Ordovician systems the quantity of limestone much exceeds that of dolomite. Here the shift of conditions is toward fresh water or land influences. True dolomites were deposited in great masses (shown by over 80 samples) but pure limestones do not occur at any place in the section. The evidence from Ohio is quite conclusive and supports the view that dolomites are the natural deposits of the ocean where the salinity of the water is about normal, that is, where the bases stand $Na > Mg > Ca$ and the acids stand $Cl > SO_4 CO_3$. On the other hand limestones are deposited when the sea waters are somewhat diluted by fresh water from land areas in which the reacting components are largely found in the ratio of bases $Ca > Mg > Na$ and of acids $CO_3 > SO_4 > Cl$ or are tending in that direction. Hence both dolomites and limestones are primary in origin and have not undergone any alteration, one to the other.

Evolution

Some excellent books on organic evolution have appeared in recent years. Each of these has considered the subject from the viewpoint of new advances in some one field of biological science. Huxley's book is unique in that he has made a synthesis of ". . . new facts or new tools of research" from many disciplines. The subject is so broad and the material so abundant that it is impossible for the author to present more than the broad principles in a book of this size. From numerous citations many of the details are left for the individual reader to work out for himself. There is a very complete bibliography and three indices, "Subjects," "Organisms" and "Authorities." The book is superbly written. Professional biologists, interested in problems of evolution, should find it on their list of books which must be read.

In the first two chapters the broad principles are stated and the plan of the book sketched. Genetics' contribution to evolution is discussed in the third and fourth chapters. This section is much reduced and assumes the readers' knowledge of the principles of heredity. The next three chapters, consisting of three hundred and sixty pages, are devoted to a discussion of geographical, ecological and genetic speciation. The inclusion of maps would have made this section more readable. In the eighth chapter Huxley maintains that adaptations are a fact and can be explained upon good "mechanistic principles." His explanation for their origin is by natural selection. In general this difficult subject is skillfully handled. However, several of his examples of adaptations imply teleology. On page 422 he states, ". . . Thus various desert butterflies spend most of their active life flying about inside quite small bushes, in order to avoid being blown away." Upon the same page we find ". . . In Equidae the subcutaneous muscle sheet is highly developed so as to be capable of strong twitching." These are peculiarities of expression and in no sense meant to be teleological.

The ninth chapter is devoted to a discussion of evolutionary trends leading to specializations. In the last chapter, the tenth, Huxley looks into the future of man. He predicts that, in the near future, man is not destined to break up into a number of separate radiating lines. Changes leading to his evolutionary progress will be concerned with the attributes of the mind. He leaves the reader with the thought that man is the trustee of his own evolution and if rapid progress is to be made he must work and plan for it.—*W. M. Tidd.*

Evolution: The Modern Synthesis, by Julian Huxley, xi and 645 pages; no text figures. Harper and Brothers, publishers, New York and London. Price $5.00.

A NEW GENUS (TENUCEPHALUS) AND SPECIES OF MEXICAN LEAFHOPPER RELATED TO PARABOLOCRATUS

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Several new and interesting generic forms of Mexican leafhoppers have recently been collected. The genus and species described below is apparently allied to *Parabolocratus* and *Spangbergiella.*

Genus Tenucephalus n. g.

In appearance resembling Parabolocratus superficially, but smaller with a short broadly rounded vertex. The vertex is broader than long, with a definite margin, but the margin is not thin or foliaceous. The face is more inflated than in Parabolocratus. The ocelli are on the margin and close to the eyes. The elytra are long and narrow and the venation resembles the Thamnotettix type. In Parabolocratus the first anteapical cell is almost as long as the second anteapical and the cross veins just caudal to these cells are in a straight line. The elytron of Tenucephalus differs in having a short first anteapical cell, a long second anteapical and a long third apical cell. The cross veins between the second anteapical and second apical are therefore decidedly more caudal than the other cross veins. The pygofer and ovipositor are extremely long and resemble the Aconuran type.

Genotype *Tenucephalus marginellus* n. sp.

Tenucephalus marginellus n. sp.

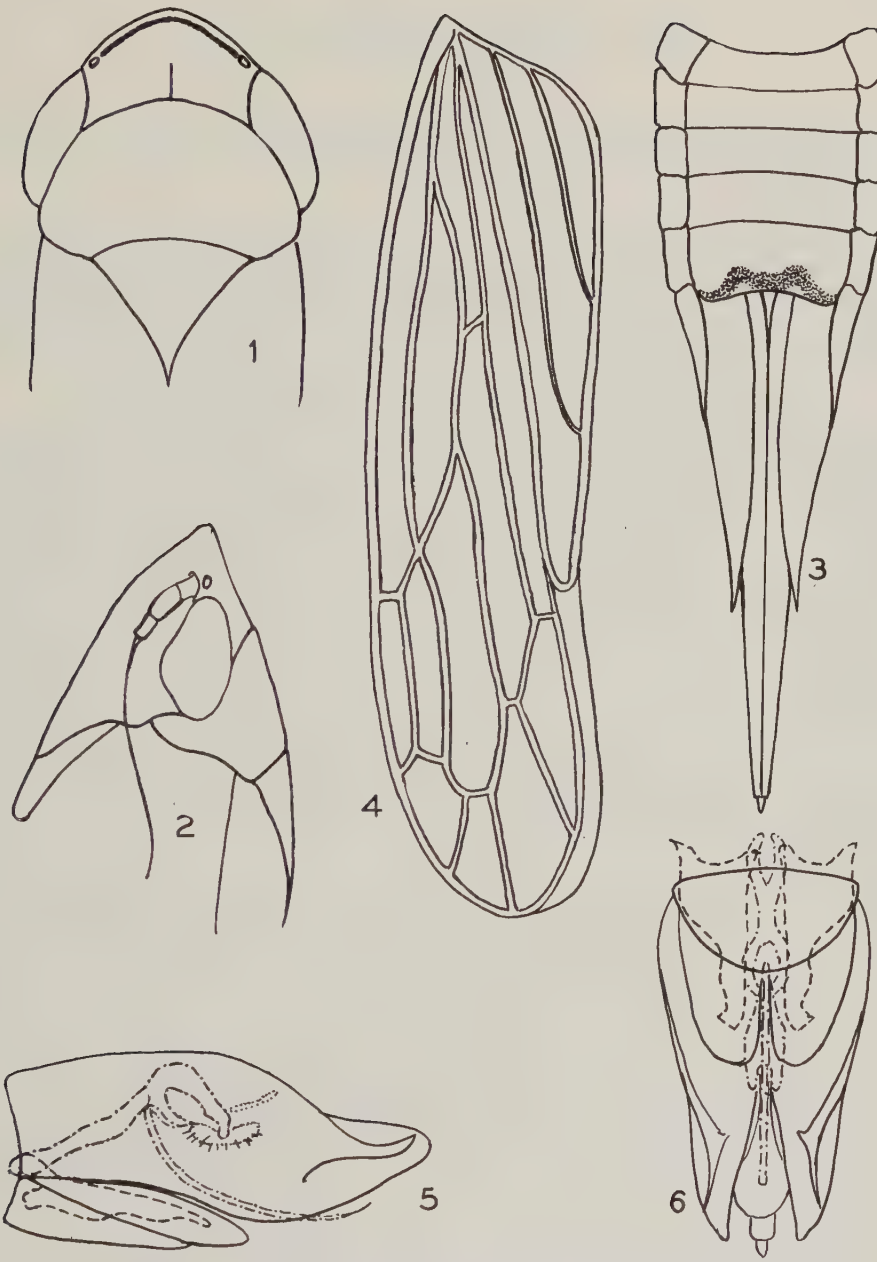
Most closely resembling *Parabolocratus viridis* but much smaller with a narrow black band just above and another just below the pale marginal band. Length, female 4.5 mm.

Vertex broadly roundedly produced, more than one-third wider between eyes at base than median length. Disc flat. Pronotum one third longer than vertex. Body slender.

Color: Dull grayish-green tinged with yellow. Vertex yellow except for a narrow black marginal line just above the pale marginal band. Another narrow black line is just beneath the marginal band. Anterior half of pronotum yellow, basal portion darker. Scutellum and beneath yellow.

Genitalia: Female last ventral segment with posterior margin broadly, concavely rounded between the produced lateral angles. The central third appears notched either side of a broad sunken tooth due to the brown markings on the segment margin and the transparent condition of the central portion of the margin. The pygofer is long, tapered and together with the ovipositor is longer than all of the abdominal segments combined. Male plates short, broadly rounded at apex. Pygofer twice as long as plates with a spine on either side arising from inner wall and concealed under apical fourth. Aedeagus forming an inverted U with the posterior arm longer and heavier than the anterior arm. At the apex of the posterior arm is a horizontal, less heavily chitinized, elongate lobe which is covered with spines on ventral margin. At the base of the U arises on the ventral side a long slender process which extends almost to apex of pygofer. Style broad at base, the apical half less than half the width of the basal portion, truncate at apex and bent outwardly.

Holotype male, allotype female and female paratypes from Iguala, Guerrero, Mexico, October 25, 1941, collected by E. E. Good and the author. Types in author's collection.



1. Dorsal view of head, thorax and scutellum.
2. Lateral view of head, thorax and scutellum.
3. Ventral view of female abdomen.
4. Lateral view of elytron.
5. Lateral view of male genital structures in situ.
6. Ventral view of male genital structures in situ.

NEW SPECIES OF ZYGNEMATACEAE[1]

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Six undescribed species of the Zygnemataceae were discovered in collections recently examined from Texas, Louisiana, and Florida. These have been described and are now being reported.

Spirogyra miamiana sp. nov.

Vegetative cells 20–25μ x 150–340μ, with plane end walls; three chromatophores (rarely 2) making 1.5 to 5 turns; conjugation scalariform, tubes formed by both gametangia; fertile cells enlarged to 41μ, length 71 to 172μ; zygospores ellipsoid to cylindric-ellipsoid, 30–39μ x 62–92μ; median spore wall composed of two layers, the outer layer wrinkled, the inner layer finely scrobiculate, yellow-brown at maturity.

U. S.: Florida, Miami Beach and Winter Park.

This species is at first attached to various underwater objects in flowing water.

Spirogyra notabilis sp. nov.

Vegetative cells 30–37μ x 92–230μ, with plane end walls; chromatophores 2, 3, or 4 making 1 to 3 turns in the cell; at conjugation the cell walls are notably thickened; conjugation scalariform between short gametangia, tubes formed by both cells, but more by the male; receptive gametangia enlarged near the spore; zygospores ovoid 48–57μ x 78–105μ, median spore wall of two yellow-brown layers, of which the outer is conspicuously punctate, the inner reticulate and finely verrucose.

U. S.: Texas, Austin, April 19, 1938.

The layers of the median wall are distinct, and among the most beautifully ornamented walls in the genus.

Spirogyra texensis sp. nov.

Vegetative cells 50–55μ x 90–530μ with plane end walls; 3 to 5 chromatophores making 1.5–3.5 turns in the cell; conjugation scalariform, tubes formed by the male gametangia; fertile cells shortened and enlarged; zygospores ovoid, 66–76μ x 99–124μ, outer spore wall transparent irregularly corrugate, median wall yellow-brown, conspicuously reticulate.

U. S.: Texas, Karnac, April 27, 1938.

Mougeotia opelousensis sp. nov.

Vegetative cells 25–28μ x 150–340μ, chromatophores with 6–12 pyrenoids in a single row; conjugation scalariform, zygospores short cylindric, with concave ends and sides, formed in the tubes, 55–64μ x 30–34μ; median spore wall yellow punctate, punctations about .8μ in diameter and evenly spaced over the entire wall.

U. S.: Louisiana, Opelousas, 1938.

Zygogonium pectosum sp. nov.

Vegetative cells 9–12μ x 12–108μ with two pillow-shaped chromatophores, sometimes elongate with flat ends; conjugation scalariform and lateral, zygospores formed in the greatly enlarged tubes; zygospores globose or subglobose (15–) 20–25μ x 18–25μ with a smooth slate blue wall; aplanospores cylindric ovoid, 9–10μ x 12–16μ, also slate blue; sporangium outer wall a 2–4μ layer of pectic compound. During conjugation the cells elongate and the walls change to pectic compounds and become greatly thickened.

U. S.: Louisiana, near Hornbeck on wet seepage slopes, April, 1938.

Zygogonium punctatum sp. nov.

Vegetative cells 9–12μ x 30–45μ with two small irregularly globose chromatophores; conjugation scalariform between gametangia that have elongated up to 115μ; zygospores globose or subglobose 18–27μ x 21–32μ, enclosed by a distinct sporangium wall; median spore wall yellow to yellow-brown, punctate.

U. S.: Louisiana, De Ridder, on roadside seepage slopes, April, 1938.

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[1]Papers from the Department of Botany, Ohio State University, No. 473.

NOTES ON LEAFHOPPERS WITH DESCRIPTIONS (HOMOPTERA: CICADELLIDAE)

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Xestocephalus superbus (Prov.)

Deltocephalus superbus Provancher, L., Petite Faune Entomologique du Canada, Hémiptères, Homoptères, Additions et Corrections, p. 339, 1890.
Xestocephalus fulvocapitatus Van Duzee, E. P., Bul. Buffalo Soc. Nat. Hist. 5: 215–16, 1894.

The following is a translation of Provancher's description:[1]

"Length .19 inch. Varied with brown and yellow; the vertex brown with numerous small pale-yellow or white spots, the edge brown with three yellow dots, the front yellow. Prothorax and scutellum brown with yellow dots or small yellow lines, the scutellum bearing four of them, two close to the base and two before the apex. Elytra pale with brown spots, the base with yellow lines in the brown. Below and legs yellow, back of the abdomen brown.—Cap. Rouge.

"Its variety of colors gives it an entirely pleasant appearance."

This description applies very aptly to fairly common, well-marked insects, with definite although sometimes faint, markings on vertex, pronotum and scutellum. Provancher's description applies more fully to males, and Van Duzee's description of *fulvocapitatus* is very accurate for females.

The inner male genitalia are also distinct in this species; the style has a broad foot, and aedeagus is stout with a long slender pair of processes.

Xestocephalus provancheri n. sp.

This slender unmarked species has been confused with the preceding from which it is readily separated by a lack of definite anterior markings and by the characters of the inner male genitalia.

A brown species with unmarked produced vertex which runs to *X. superbus* (Prov.) in Peters' key.[2]

Head narrower than pronotum, a little less than twice as wide as long, an eighth longer at middle than next to eye, strongly produced. Pronotum one-fourth longer than vertex, a little more than twice as wide as long, elytra long and slender, strongly exceeding abdomen.

Vertex, pronotum and scutellum yellowish brown, eyes dark, area below eyes on pronotum darkened, scutellar basal angles dark, area around ocelli light. Elytra semihyaline with opaque white patches over costal plaque, dark areas on costal margin, one at middle, another above apical cell, a square area below apex of clavus, and apical cells. Below, face and legs pale, venter and dorsum dark, usually darker in female.

Male, aedeagus with short pair of processes reaching about half length of shaft and style with narrow foot. Female last ventral segment more than twice as long as broad, almost straight, slightly notched at middle, pale spines of pygofer not as abundant as in other species, ovipositor exceeding pygofer.

Length: male, 3 mm.; female 3.25 mm.

Male holotype, female allotype and three paratypes, Columbus, Ohio, May 19, 1938, D. J. & J. N. Knull, Collectors. Paratypes from Ohio: Franklin Co., July 14, 1942; Clifton, June 14, 1938; Delaware Co., June 20, 1943; and Hocking Co., May 25, 1938, and June 3, 1943, D. J. & J. N. Knull; Madison Co., Sept. 7, 1931, E. P. Breakey; Ironton, May 26, 1898, H. Osborn Collection. Paratypes from other states: Maud, Texas, April 29, 1941, D. J. & J. N. Knull; Gaines-

[1]Kindly checked by Professor Wencel J. Kostir.
[2]Peters, H. T., J. Kans. Ent. Soc. vi: 73–4, 1933.

ville, Fla., April 7, 1924, T. H. Hubbell; Agr. College, Miss., May 5, 1921, and Longview, Miss., April 9, 1921, A. McIntosh.

All type material is in the Ohio State University Collection.

Xestocephalus tucsoni n. sp.

Robust, markings of vertex, pronotum and scutellum dark brown to black on tan background; elytra largely semihyaline with dark brown clouding, two inner claval veins conspicuously white toward sutural margin and near humeral angle. Inner male genitalia readily separate it from all other species as there are two pairs, instead of the usual one pair of spines on the aedeagus.

Head narrower than pronotum; vertex more than three times as broad as long, twice as long at middle as next to eye, slightly produced; pronotum more than half longer than vertex, two and three-eighths times as wide as long, humeral and lateral margins equal; elytra exceeding abdomen. Tarsal claws straight, curved ventrad.

Dark brown irregular mottling on vertex and pronotum, light and dark areas covering about equal amounts of surface, scutellum very dark, with a bluntly triangular basal white spot either side of middle and on mid-lateral margins. Elytra semihyaline, dark dorsum of insect showing through to give them a dark cast, claval veins whitened as mentioned above, square area below apex of clavus brown, corium largely semihyaline with some rounded hyaline spots margined with brown and small brown areas at ends of apical veins. Face brownish black with trace of pale arcs on front, on upper part a dark bat-shaped figure enclosed by light area. Venter very dark, legs lighter.

Male, aedeagus differing from that in all other species in having two pairs of latero-ventral processes, the outer pair longer; style with broad foot, rounded apex toothed on inner half of margin. Female, last ventral segment more than twice as long as preceding, posterior margin with sides sloping faintly up toward middle where there is a minute notch at the base of a slit which extends almost half length of segment. Pygofer dark brown, apex of ovipositor darker, exceeding pygofer, sides of pygofer with profuse, long, stout, tan spines.

Length: male, 3.2 mm.; female 3.5 mm.

Holotype male and allotype female from Tucson, Arizona, collected July 12, 1937, by D. J. & J. N. Knull, and deposited in the Collection of The Ohio State University.

Stirellus osborni n. sp.

The smallest, darkest member of the genus.

Head as wide as pronotum; vertex a little longer at middle than width between eyes, half longer at middle than next to eyes, eyes large. Pronotum two and one-half times as wide as long, as long as vertex at middle, lateral margins very short, humeral margins long, posterior margin transverse, disc transversely striate especially on posterior two-thirds; elytra exceeding abdomen in male, exceeded by apex of ovipositor in female.

Female, uniform rich brown with the following light areas: a spot at apex of vertex, traces of light pattern on disk and base; pronotum, indication of median longitudinal stripe, apex of scutellum; elytra, claval veins and elytral area extending from above inner apical cell, obliquely

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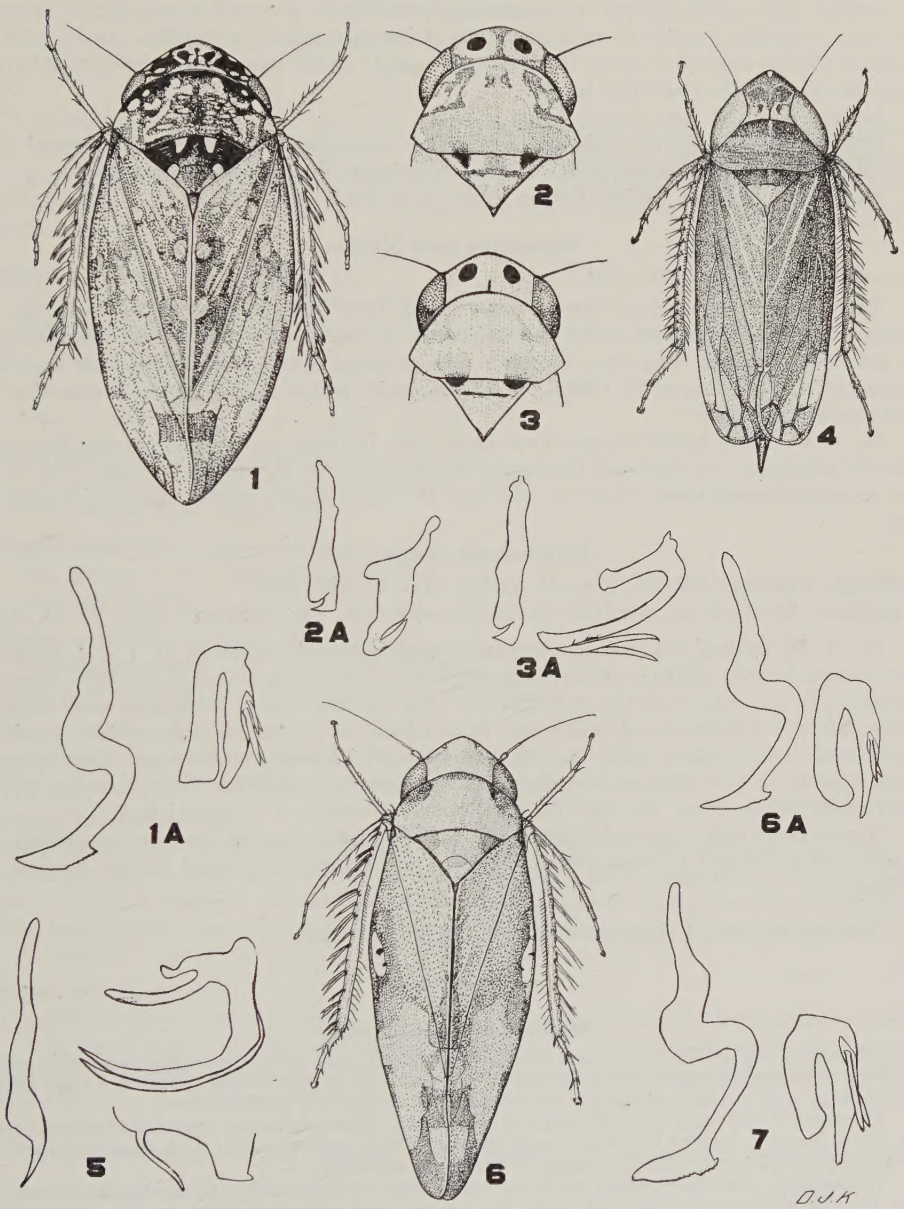
EXPLANATION OF PLATE

1. *Xestocephalus tucsoni* n. sp., female; 1A. Inner male genitalia, lateral view of style and aedeagus.
2. *Erythroneura apacha* Baker, female; 2A. Inner male genitalia, lateral view of style and aedeagus.
3. *Erythroneura balli* Beamer, female; 3A. Inner male genitalia, lateral view of style and aedeagus.
4. *Stirellus osborni* n. sp., female.
5. *Dikraneura mera* McAtee, inner male genitalia, lateral view, style, aedeagus and posterior margin of ninth segment.
6. *Xestocephalus provancheri* n. sp., female; 6A. Inner male genitalia, lateral view of style and aedeagus.
7. *Xestocephalus superbus* (Prov.), inner male genitalia, lateral view of style and aedeagus.



Note: Figs. 1, 4 and 6 to same scale; 2 and 3 to same scale; and all illustrations of inner male genitalia to same scale.

on anteapicals, to costal margin, apical cells dark and veins embrowned. Male, uniformly dark but for pale apex of scutellum, below dark in male, in female with white ocelli and oval pale area just below clypeal suture; spines of legs pale in both sexes.

Female, last ventral segment about as long as penultimate, posterior margin slightly concave; ovipositor exceeding pygofer by twice its width; a few pale spines on pygofer. Male, genitalia similar in form to those of *S. bicolor* (V. D.) as illustrated,[3] except that the pygofer extends beyond the plates by more than half their length.

Length: male, 2.5 mm.; female 3 mm.

Holotype female, allotype male and eight female paratypes collected near Homestead, Fla., Feb. 16, by Herbert Osborn and in the Osborn Collection at The Ohio State University.

Named for Professor Herbert Osborn, collector of the type series.

Dikraneura mera McAtee

Proc. Ent. Soc. Wash. 26: 76, 1924.

This species was described from a single female from Maryland taken on white oak. A number of specimens has been taken from white oak in Tennessee and Ohio, and since the male has not been described, a figure of the inner male genitalia is presented, and a male specimen, Delaware Co., Ohio, August 27, 1942, D. J. & J. N. Knull, is made the allotype and placed in the collection of the author.

Dr. P. W. Oman kindly compared specimens with the type and assured me that they were correctly identified. In McAtee's description he indicates that the clavus is black. This is not true in any of the specimens I have at hand, and Dr. Oman did not mention that it is true of the type.

Erythroneura apacha Baker

Typhlocyba bipunctata Gillette, *Proc. U. S. Nat. Mus.* 20: 751, 1898.
Erythroneura apacha Baker, nom. nov. for *E. bipunctata* Gill., *The Philipp. J. of Sci.* 27: 537, 1925.

Dr. D. M. DeLong has recently compared female specimens taken by D. J. & J. N. Knull near Tucson, Arizona, with the female (wingless) type of *E. apacha* Baker, in the U. S. National Museum, and has noted that the markings are "just like the type." Specimens were taken at light and from a low-growing *Acacia* in the Tucson Mts., and in Sabino Canyon on a number of occasions on dates ranging from May 13 to August 27. A study of the inner male genitalia shows them to be quite distinct from those in Dr. Beamer's *E. balli* (*J. Kans. Ent. Soc.* 5: 125, 1932) which he later (*Can. Ent.* 66: 175, 1934) made a synonym of *E. apacha* Baker.

It is my belief that *E. apacha* Baker and *E. balli* Beamer are separate and distinct species, and illustrations are offered to show their differences. Specimens determined by Dr. Beamer are at hand.

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[3]Thomas, Ruth L., J. Kans. Ent. Soc. vi: 136, Pl. II, 1933.

Methods of Plant Breeding

Although designed for use in advanced undergraduate and graduate classes in plant breeding this book is somewhat more than a classroom textbook. It is in addition a reference work on the methodology and genetics applicable to programs of crop-plant improvement.

The genetic basis and the methods and technics of improvement by hybridization and selection are thoroughly treated for all our crop plants. The chapters dealing with approved methods of field-testing new varieties or strains for yield are excellent.

Throughout, the discussion centers around illustrative examples from the literature and from the extensive research carried on by the authors and their students.

The text proper is supplemented by a list of over four hundred references, statistical tables useful in analysis, and a glossary consisting mostly of general botany and elementary genetic terminology.

The book is sturdily bound and the type is easily read. In this reviewer's opinion, a few more illustrations would be a decided improvement.—*R. T. Wareham.*

Plant Breeding, by Herbert Kendall Hayes and Forrest Rhinehart Immer. 432 pp. New York, The McGraw-Hill Co., 1942. $4.00.

NOTES ON ZYGNEMATACEAE[1]

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During the past year an effort has been made to revise my keys to the genera and species of the Zygnemataceae. Many old specimens have been re-examined and many new collections have been studied. As a result of these investigations the following changes in specific designations are proposed, and four new species are described.

Spirogyra triplicata (Collins) comb. nov.
=*S. decimina* var. *triplicata* Collins 1912.
Phycotheca Bor.-Amer. No. 960; also Green Algae of North America, p. 110.

Spirogyra tropica (G. S. West) comb. nov.
=*S. decimina* var. *tropica* W. & G. S. West 1901.
Flora of Koh Chang, Bot. Tidsskr. 24: 161.

Spirogyra bichromatophora (Randhawa) comb. nov.
=*S. gallica* var. *bichromatophora* Randhawa 1938.
Proc. Indian Acad. Sci. 8: 353.

Spirogyra minor (Schmidle) comb. nov.
=*S. malmeana* var. *minor* Schmidle 1901.
Hedwigia 40: 47.

Spirogyra prescottii (Prescott) comb. nov.
=*Spirogyra collinsii* var. *minor* Prescott 1942.
Amer. Midland Naturalist, 27: 673, Pl. 4, Fig. 15–17.

Spirogyra regularis (Cedercreutz) comb. nov.
=*Spirogyra reticulata* var. *regularis* Cedercreutz 1924.
Acta. Soc. pro Fauna et Flora Fennica 55, No. 2, p. 3.

Spirogyra taftiana sp. nov.
Vegetative cells 18–25μ x 50–96μ with plane end walls, one chromatophore making 2–4 turns in the cell; conjugation scalariform, tubes formed by both gametangia; receptive gametangia enlarged or fusiform inflated; sterile cells often bulliform; zygospores ellipsoid 24–34μ x 42–80μ, median wall yellow, distinctly and densely punctate, pits more or less angular.
Huntsville, Texas (C. E. Taft Collection).

Spirogyra visenda sp. nov.
Vegetative cells 40–45μ x 130–150μ, with plane end walls; one narrow chromatophore making 4–9 turns in the cell; conjugation scalariform, with broad tubes formed wholly by the male gametangia; receptive gametangia inflated to 60–80μ; zygospores ellipsoid, sometimes ovoid 55–65μ x 92–124μ, median spore wall yellow, smooth.
Columbus, Missippi, April 14, 1925.
Both gametangia are reflexed and the conjugating pairs are separated by vegetative cells.

Sirogonium melanosporum (Randhawa) comb. nov.
=*Sirogonium ventersicum* var. *melanosporum* Randhawa 1938, Proc. Indian Acad. Sci. 8: 364.

Sirogonium pseudofloridanum (Prescott) comb. nov.
=*Spirogyra pseudofloridanum* Prescott 1944, Farlowia 1: 360–361, Fig. 1.

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[1]Papers from the Department of Botany of the Ohio State University No. 472.

Sirogonium megasporum (Jao) comb. nov.
= *Sirogonium sticticum* var. *megasporum* Jao 1935, Sinensia 6: 645, Pl. 12.

Sirogonium hui (Li) comb. nov.
= *Spirogyra hui* Li 1938, Bull. Fan Inst. Biol., Bot. Ser. 8: 91.

Zygnema cylindrospermum comb. nov.
= *Z. stellinum* var. *cylindrospermum* W. & G. S. West 1905.
Transac. & Proc. Bot. Soc. Edinburgh 23: 3–40, Pl. 1, Fig. 2–5.

Zygnemopsis orientalis comb. nov.
= *Debarya desmidioides* var. *orientalis* Carter 1926.
Records Bot. Survey of India 9: 281.

Zygnemopsis tiffaniana comb. nov.
= *Debarya cruciata* Price 1911. New Phytologist 10: 87; idem 11: 60.
Also *Zygnemopsis cruciata* (Price) Transeau 1934, and *Mougeotia cruciata* (Price) Czurda 1932.

Debarya ackleyana sp. nov.

Vegetative cells 12–15μ x 90–140μ with a single ribbon-like axile chromatophore with about 8 pyrenoids; conjugation scalariform, tubes long and slender at first, later the median spore wall becomes rounded and the sporangium wall is perfectly distinct; zygospore golden yellow mostly compressed globose, sometimes ovoid, 50–54μ x 52–65μ, median wall tricarinate, the lateral keels finely ruffled and very distinct, with corresponding corrugations between the keels; the middle keel thin, radially striate and up to 10μ wide; polar walls obscurely pitted and without a "hub."

U. S.: Michigan (Ackley Coll.), Massachusetts (Bullard Coll.).

Named for Dr. Alma Ackley of Wayne University who collected the type specimens near Douglas Lake, Michigan.

Mougeotia africana comb. nov.
= *Debarya africana* G. S. West 1907. Jour. Linn. Soc. Bot. 38 104, Pl. 5, Fig. 3.

Mougeotia rava sp. nov.

Vegetative cells 8–12μ x 30–120μ, chromatophore with 4 to 8 pyrenoids in a row; reproduction by aplanospores which are formed mostly outside the recurved sporiferous cells; aplanospores globose 16–20μ in diameter, median wall gray-brown and smooth.

U. S.: Mississippi, Starkville; Louisiana, Alexandria (Hicks Coll.); Texas, Austin (Taft Coll.).

This species resembles *M. calcarea*, but differs in being aplanosporic and having gray-brown spores.

Practical Malaria Control

This pocket-sized manual for the control of malaria is well described by its title and subtitle given below. It is an abbreviated treatise, yet many items appear which are new, and some are considered in detail. The subject matter is treated very systematically and is divided into four parts: 1, Antimalarial Measures; 2, Diagnosis; 3, Treatment; and 4, Complications of Malaria.

The author, both an entomologist and a physician, has spent many years in the tropical jungle of New Guinea where malignant tertian malaria is highly endemic. People concerned with the control of malaria in similar situations should find this book to be a great help, although its use is not restricted to such areas.

The publisher, it is assumed, is responsible for printing the book on undesirable paper and without a table of contents and index. Also, the price is large for the size of the book. These facts are mentioned because they should not deter one from purchasing this manual for the excellent contribution the author has made to the literature on control of malaria.

Practical Malaria Control. A handbook for field workers, by Carl E. M. Gunther. 91 pages, 1944. Philosophical Library, Inc., 15 East 40th St., New York, N. Y. Price, $2.50.